TECHNOLOGY DEPT. JUN -1 1941 First Copy

June 1941

TECHNOLOGY REVIEW

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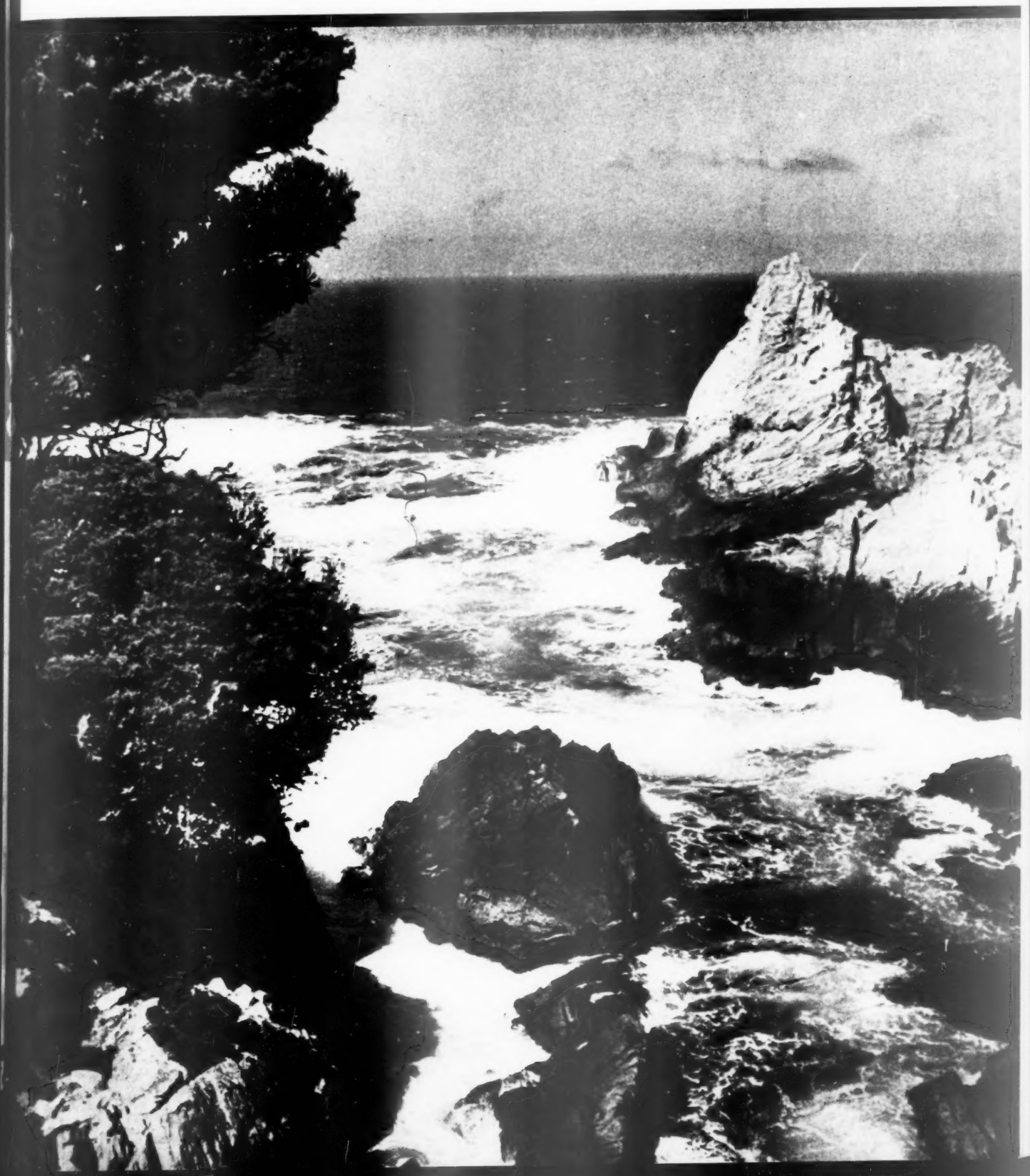
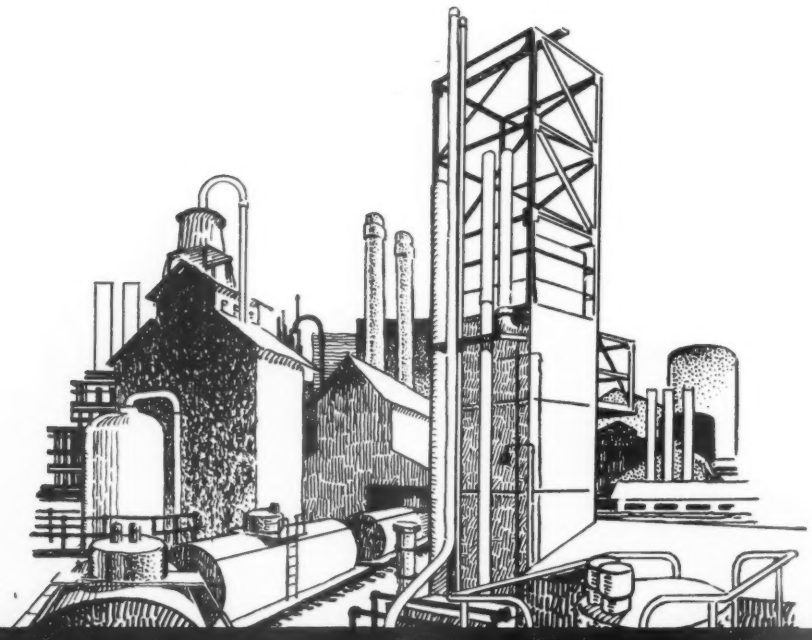


BADGER.....

three Cs and a G

in Chemical Engineering



Cooperation with clients' enginee in working out the flowsheet deta of the process and construction d tails of the entire plant.

Coordination of the construction. purchases, fabrication, inspection a delivery of equipment and materia

Completion of the project under th direct supervision of skilled constru tion superintendents and foreme making use of local labor both skille and unskilled.

Guarantee fully met.

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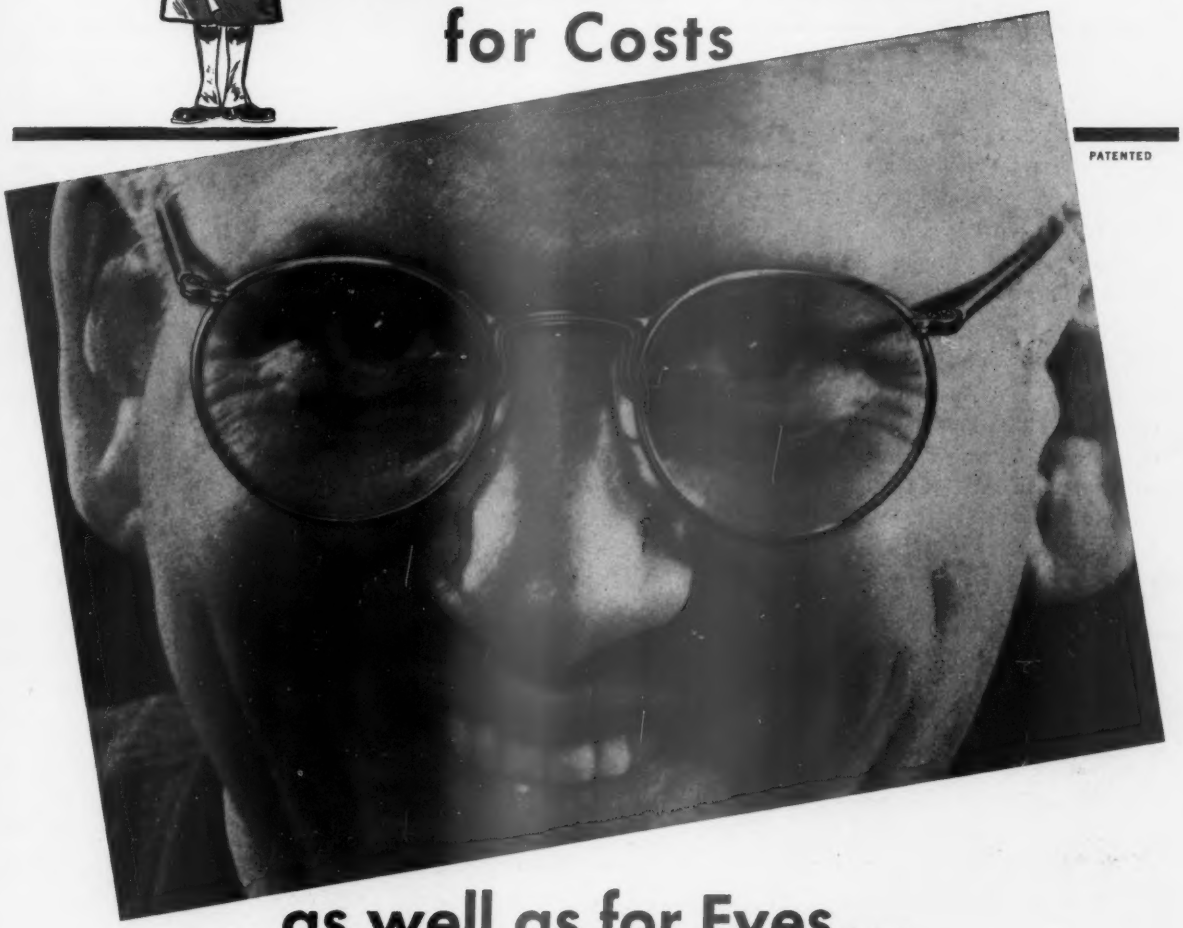
JUN -1 1941

Goggles Do GUARD DUTY for Costs



PATENTED

as well as for Eyes...

American Goggles guard against flying chips that might destroy or injure workers' eyes, upset work-schedules, boost production costs. Equipped with Super Armorplate Lenses, American Goggles provide greater resistance to impact. Designed and made by experienced optical craftsmen, they are light, cool and comfortable to wear.

Do you have a *complete* eye protection program in your plant? It *pays* to have one . . . to provide *every one* of your workers with the type of American equipment designed to protect his sight—and *your* dollars. Ask your AO representative to show you the entire American line and the *figures* of what well planned eye safety programs are doing for other manufacturers.

American Optical Company

SOUTHBRIDGE, MASSACHUSETTS, U. S. A.

MANUFACTURERS, FOR MORE THAN 100 YEARS, OF PRODUCTS TO AID AND PROTECT VISION

THE TECHNOLOGY REVIEW, June, 1941. Vol. XLIII, No. 8. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

THE MIRACLE OF MARCUS HOOK

THIRTY YEARS AGO, on December 19, 1910, a group of engineers and scientists gathered in a new, unusual plant at Marcus Hook, Pa. This was to be the first commercial production of a man-made textile fiber in the U.S.

Finally, someone gave a signal. Machinery sprang to life. And from the equipment there began to issue slender filaments which were led through a chemical solution, then collected in the form of yarn.

A new American textile industry was born!

The progress of America's rayon industry in the thirty years that have passed since that first successful production in the Marcus Hook Plant of American Viscose Corporation is now history. Rayon has marched steadily ahead as it has made possible new, more beautiful and more durable fabrics. Today, it employs 49,000 American men and women, and annually produces more than 300 million pounds of yarn. An outstanding example of American achievement.

From the first, American Viscose Corporation has figured prominently in every major development. It pioneered many vital advances for cost reduction, price reduction, and quality improvement. It established the Crown* Quality Control Plan to assure consumers the quality they want in rayon merchandise. It instituted the "Textile Unit," a full-sized textile research plant, in order to better serve the industry.

American Viscose Corporation is proud of its 30-year record of achievement. And now, embarking on its fourth decade, it pledges continuance of the progressive policies which have stimulated the growth of the American rayon industry.

Roster of M.I.T. Men in American Viscose Corporation

★

Paul G. Woodward	'17	X
Hobart O. Davidson	'20	II
Hugh D. Haley	'22	VI
Bernard M. Morgan	'26	XV
Alvin Lodge	'29	II
Ross M. Pfalzgraff	'29	VI
D. B. Wicker	'29	X
W. F. R. Griffith	'31	VI
John E. Spalding	'31	X
Stanley L. Whitcher	'31	V
W. Stewart Roberts	'32	II
Ivanhoe P. Denyssen	'34	VI
Scott Brodie	'40	IX
Nicholas E. Carr	'40	X
William P. Dooley	'40	X
N. B. Duffett	'40	X
Mason B. Lindsey	'40	X

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350 Fifth Avenue, New York • *World's Largest Producer of Rayon Yarn*

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PLANTS IN . . . MARCUS HOOK, PA.
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ROANOKE, VA. • LEWISTOWN, PA.
MEADVILLE, PA. • FRONT ROYAL, VA.

CROWN TESTED AND APPROVED RAYON FABRIC

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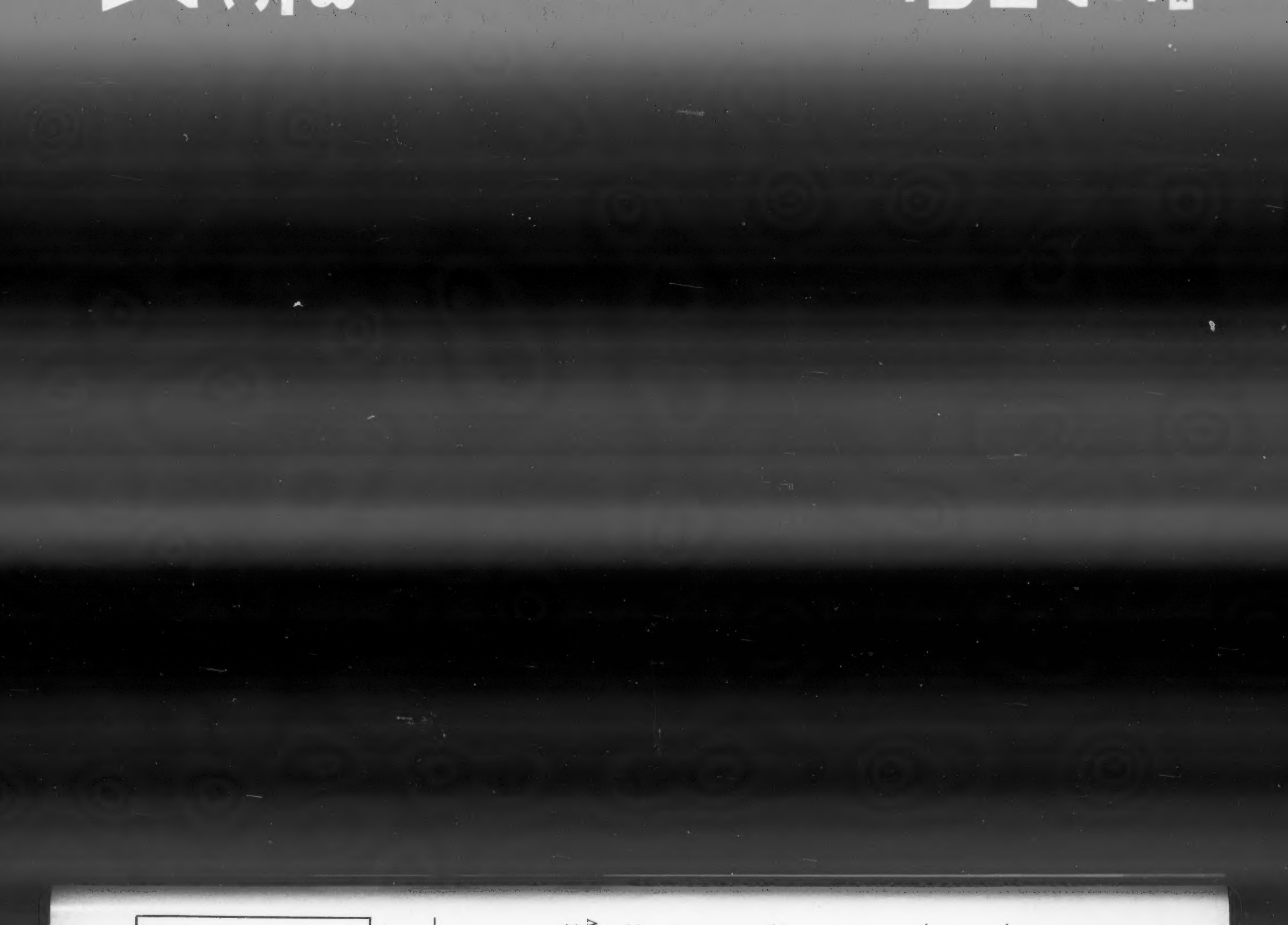
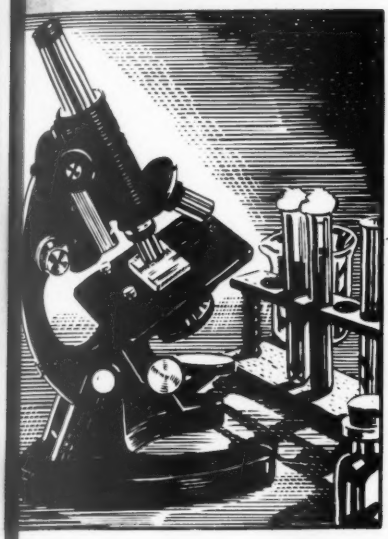


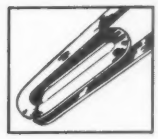
RESEARCH·

To Phelps Dodge Copper Products Corporation

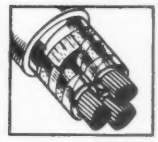


research is not an abstract policy. It is a carefully directed and powerful group-effort to effect industrial progress. By imagination, perception and scientific curiosity, its research staff has combined technical knowledge and realistic concept, to make research a dynamic tool for progress.

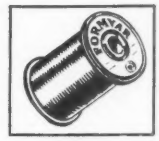
PHELPS DODGE COPPER PRODUCTS CORPORATION



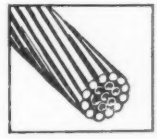
P.D.C.P. COPPER. Ordinary electrolytic copper cathode is plastically converted by tremendous pressure into smooth, dense copper bars, rods and strips.



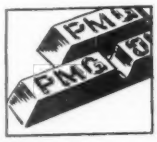
"TITEBILT" PAPER CABLE is so constructed as to undergo cyclical expansion and contraction with daily variations in power load without deterioration.



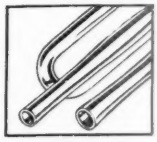
FORMVAR—a new synthetic type resin insulated magnet wire, highly resistant to abrasion, and resistant to water absorption.



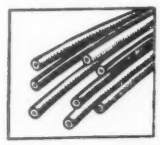
P.D.C.P. HOLLOW TRANSMISSION CABLE consists of solid wires stranded around a core of hollow wires which saves weight and reduces corona losses.



P-M-G a casting metal hardener for maufacture of silicon bronze metal with higher physical properties and lower specific gravity than conventional tin bronzes.



DUAL-GAUGE TUBING provides heavier wall thickness by changing the outside diameter at points of support, at tube ends, and on return bends.



SYNTHETIC SMALL DIAMETER BUILDING WIRE has an insulation of synthetic resin and is highly resistant to moisture, oil, acids, alkalis and sunlight.

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No. 35

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A CHALLENGE

TO YOUR INGENUITY

SEE if you can specify (approximately) *all* possible starting points for an aeroplane flight in which the pilot is first to fly 600 miles due south, next 600 miles due west, then 600 miles due north to his initial position.

Answer:

The north pole, or any properly chosen point about [600+95.5/n] miles north of the south pole (n=a positive integer). We got much of the new life for this old "What was the color of the bear?" puzzle from G. L. Kaufman's column in the *Newark* [N. J.] *Evening News*.

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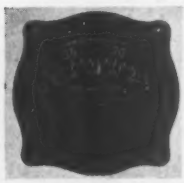

This flight instrument determines the Fuel-Air Ratio by analyzing a sample of the exhaust gas. It provides a continuous guide enabling the pilot to control accurately the all-important mixture ratio from sea level to the highest altitude. This instrument is used on air transports and military ships throughout the world. Cambridge Precision Instruments are available for both science and industry.

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THE TABULAR VIEW

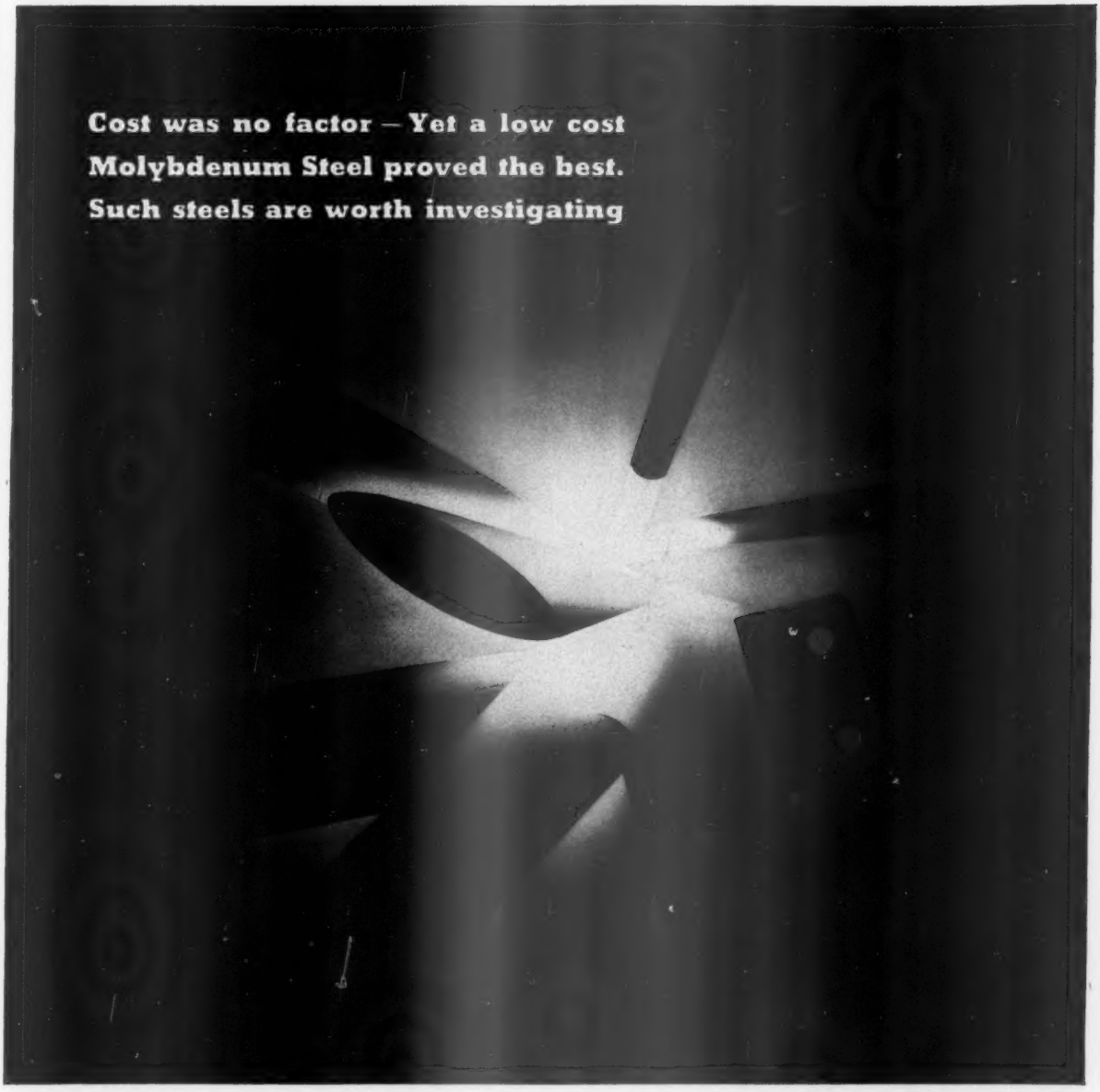
Choice. — Inability or unwillingness to make a firm decision between alternatives lies at the root of Europe's present tragedy, as KARL T. COMPTON, President of the Institute, clearly points out in his penetrating essay (page 347) which opens this issue of The Review. In its calm counsel of a course for America, Dr. Compton's essay, based on his commencement address at Webb Institute of Naval Architecture, is an apt tract for the times.

Short? — Modern warfare is so much a function of supplies that appraisals of who has how much of what are among the most important factors determining the course of events. The petroleum supplies of the Axis powers, drain on which is increasing with every conquest, are hence a center of speculation. ROBERT E. WILSON, '16, President of the Pan American Petroleum and Transport Company and consultant, petroleum unit, Office of Production Management, surveys this situation for The Review (page 349) in an authoritative article. Dr. Wilson is to be commencement speaker at the Institute this month.

Levels. — Devotees of lens and film, with the summer opening before them, will find sound guidance in PAUL J. WOOLF'S discussion of composition in photography (page 351). Mr. Woolf, many of whose photographs have in the past contributed distinction to The Review's pages, is a shrewd critic as well as a sensitive and able photographer.

Denominator. — From the time when the sling replaced the thrown stone, practically every war has witnessed the use of new weapons, so that the observer of war today is confronted by a confusing array of lethal instruments. Efforts to find a basis of comparison among them are necessarily hampered by lack of knowledge and by the great disparities differentiating the foot soldier, for instance, from the bombing plane. JOHN W. MEADER, '19, economist and statistician whose ingenious mind is well known to Review readers, proffers in this issue (page 355) a theory of one common denominator of tactical power.

Oldsters. — As the median age of the population increases, and as civilization so shapes as to profit more and more from experienced skill, the problems of the diseases of oldsters become of greater social import. Dr. EDWARD J. STIEGLITZ, who discusses them for The Review (page 358), speaks with authority which is his as a member of the unit on gerontology, division of chemotherapy, National Institute of Health, of the United States Public Health Service. Dr. Stieglitz' essay is drawn from a lecture which he delivered at Technology under the auspices of Delta Omega, honorary public health society. Introducing him then, Samuel C. Prescott, '94, Dean of Science, cited Dr. Stieglitz' work and remarked that "science looks forward, not to terrestrial immortality but to fullness of life, and previsions a time when the fires of life may lessen gradually and naturally." (*Concluded on page 336*)



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MOLY

ALUMNI DAY AT TECHNOLOGY—JUNE 9

June 6-7-8 and earlier

CLASS REUNIONS — Classes whose numerals end in 1 or 6 hold reunions in 1941. All class gatherings, however, whether they precede or follow Alumni Day, include in their programs an opportunity for members of these classes to return to Technology for Alumni Day, Monday, June 9.

June 8

Dr. Compton's supper — Engineers Club, 2 Commonwealth Avenue, Boston — for Honorary Secretaries and Officers of Alumni Clubs. Informal Dress.

June 9—Alumni Day

MORNING

8:30 A.M.–10:00 A.M. Registration for Alumni, Alumnae, and their guests in the Rogers Lobby. Tickets previously ordered may be obtained at the registration desk. There will be a registration charge of $1.50 for those not purchasing blanket tickets. Payment of this registration fee will permit Alumni to attend the conference on "Science and Engineering as Allies of Medicine" and the Luncheon.

Tickets for these events cannot be purchased in advance of June 9 except by the purchase of a $5.00 blanket ticket.

10:00 A.M. **Conference, "Science and Engineering as Allies of Medicine."** Huntington Hall (Room 10–250). Admission by ticket only, until 9:55 A.M.

Presiding Officer — Dr. Samuel C. Prescott, Dean of Science and Head of the Department of Biology and Public Health, Massachusetts Institute of Technology.

SPEAKERS

¶ Frank H. Lahey, M.D., Harvard College, 1904; assistant professor and later professor of surgery, Tufts Medical School, 1913–1917; director of surgery, American Expeditionary Forces, Evacuation Hospital No. 30, and Major, Medical Corps, World War; professor of clinical surgery, Harvard Medical School, 1923–1924; at present director of surgery, The Lahey Clinic, Boston; surgeon-in-chief, New England Deaconess Hospital; surgeon-in-chief, New England Baptist Hospital; member, American Surgical Association, American Association for Study of Goitre, International Surgical Association, Société des Chirurgiens de Paris; fellow and member of the board of governors, American College of Surgeons; President-elect, American Medical Association.

Subject:

"THE ACCOMPLISHMENTS OF SCIENCE IN MEDICINE"

¶ George R. Harrison, A.B., Stanford University, 1919; A.M., 1920; Ph.D., 1922; instructor, Stanford 1919–1923; National Research fellow, Harvard University, 1923–1925; assistant professor of physics, Stanford, 1925–1927; associate professor, 1927–1930; Professor of Physics and Director of the Research Laboratory of Experimental Physics, M.I.T., since 1930; Director of Applied Physics since 1935; awarded Rumford Medal, 1939; author, *Atoms in Action*, 1939, *M.I.T. Wavelength Tables*, 1939; editor, *Journal of the Optical Society of America;* inventor, automatic comparator, spectroscopic interval sorter, interval recorder, high-speed spectrophotometer; director, Optical Society of America; member of the board of governors, American Institute of Physics; member, American Physical Society, American Academy of Arts and Sciences, American Astronomical Society.

Subject:

"NEW TOOLS OF THE PHYSICIST FOR THE PHYSICIAN"

¶ Detlev W. Bronk, A.B., Swarthmore College, 1920; honorary Sc.D., 1937; M.S. University of Michigan, 1922; Ph.D., 1926; assistant professor of physiology and biophysics, Swarthmore, 1926–1927; associate professor, 1927–1928; professor, 1928–1929; chairman of the department of zoology, 1927–1929; dean of men, 1927–1929; National Research Council fellow in medical science, Cambridge and London universities, 1928–1929; Johnson professor of biophysics and director of the Eldridge Reeves Johnson Research Foundation for Medical Physics, University of Pennsylvania, 1929–1940; professor of physiology and chairman of the department of physiology and biophysics, Cornell University Medical College, New York City; managing editor, *Journal of Cellulose and Comparative Physiology;* member of the editorial board, *American Journal of Physiology*, *Proceedings* of the Society of Experimental Biology and Medicine, *Biological Abstracts*, *Journal of Applied Physics;* fellow, American Association for the Advancement of Science; member, National Academy of Sciences, American Philosophical Society, American Physiological Society, British Physiological Society, American Physical Society, division of physics of the National Research Council, Optical Society of America, American Neurological Association, American Society of Naturalists, Society for Experimental Biology and Medicine; honorary member, Harvey Society, American Society of Anesthetists; corresponding member, Société Philomathique de Paris.

Subject:

"FUTURE OPPORTUNITIES OF THE PHYSICAL SCIENCES IN MEDICINE"

Exhibits

This symposium program, with extensive exhibits in both the Main and Rogers Lobbies showing working models of apparatus developed by scientists and engineers for the diagnosis and cure of disease, offers Alumni a noteworthy opportunity to inform themselves on the growing importance of the work of the scientists and engineers in aiding the progress of medicine. Included among the exhibits will be the following:

(1) *Brain-Wave Apparatus*

Apparatus used in recording and analyzing brain waves will be set up and in operation. This exhibit will include descriptive material showing how several types of abnormalities can be detected by brain-wave analysis.

JUN -1 1941

ALUMNI DAY AT TECHNOLOGY—JUNE 9

(2) *Electrocardiography*

The wave form of the electric impulses accompanying heart beats will be continuously recorded, and a projection oscilloscope will give a continuous visual record of heart beats. This exhibit will be accompanied by appropriate sound effects.

(3) *Ultraviolet Light*

Apparatus and illustrative material relating to the bactericidal and vitamin-producing effects of ultraviolet light will be exhibited.

(4) *Radio-active Indicators*

An exhibit illustrating the many uses in science and medicine of artificially radio-active materials as "indicators" will be prepared. In this exhibit a biological specimen will be inoculated with a submicroscopic amount of artificially radio-active material, the presence of which will be made evident by Geiger-counter apparatus.

(5) *Vitamins and Food-Concentrates*

This is an exhibit showing fluorophotometric apparatus for measuring vitamin content. In addition it will show the practical and strategic possibilities of highly concentrated foods.

(6) *Spectrographic Analysis*

Apparatus will show the usefulness in medical science of spectrographic analysis employing visible and ultraviolet light.

(7) *High-Voltage X-Ray Generators*

A scale-model exhibit will show the progressive development in recent years of high-voltage x-ray apparatus for cancer treatment. A 1.25-million-volt x-ray generator will be part of this exhibit.

(8) *Cyclotron and Nuclear Generator*

A one-quarter-scale model of the M.I.T. cyclotron will be set up in the lobby with descriptive material on both the cyclotron and the high-voltage nuclear generator.

(9) *Flow by Refringence*

Double refraction of flow will be demonstrated, in which the flow patterns produced by goldfish swimming in a dilute solution of tobacco mosaic virus are revealed by polarized light.

PERMANENT EXHIBITS

Cyclotron Laboratory
X-Ray and Cathode-Ray Laboratory
High-Voltage Nuclear Laboratory
Solar Energy Laboratory
Spectroscopy Laboratory
Electron Microscope Laboratory
X-Ray Diffraction Laboratory devoted to proteins, sterols, and viruses

AFTERNOON

12:30 P.M. Luncheon for all Alumni and their guests in Du Pont Court. Tickets required. Special tables for the 50th (1891) and the 25th (1916) reunion classes, and for their lady guests.

2:00 P.M. Class Day Exercises in Lowell Court, featuring the Senior Class and the Classes of 1891 and 1916.

Prominent speakers, including representatives of the Alumni Association, 50th year, 25th year, and Senior Classes. During the Class Day Ceremonies, the present Senior Class of 1941 will be initiated officially to membership in the Alumni Association.

4:00 P.M. Special ceremonies celebrating 25 years of Technology's home on the Charles, including the dedication of a memorial to our former President Maclaurin. Main Lobby.

4:30 P.M. Unveiling of portrait of President Compton in the Rogers Lobby.

EVENING

7:00 P.M. Alumni Banquet at the Hotel Statler. The high lights of the evening will be a short program on "Twenty-five Years of Technology on the Charles" and remarks by Dr. Compton on the progress of Technology during the past year. Informal dress.

Tables will be provided for nonalumni members of the Corporation and Institute Staff.

Program for the Ladies

8:30–10:00 A.M. Registration in Lobby of Rogers Building.
9:00–10:00 A.M. Coffee served in Emma Rogers Room.
10:00 A.M. Conference "Science and Engineering as Allies of Medicine."
12:30 P.M. Luncheon in Du Pont Court.
2:00 P.M. Class Day Exercises.
4:00 P.M. Special ceremonies celebrating 25 years of Technology's home on the Charles, including the dedication of a memorial to our former President Maclaurin. Main Lobby.
4:30 P.M. Unveiling of portrait of President Compton in the Rogers Lobby.
4:00–5:30 P.M. Open house at the home of Mrs. Karl T. Compton, just below Walker Memorial on Charles River Road.
5:30 P.M. Busses leave from President's House and proceed to Brae Burn Country Club, 326 Fuller Street, Newton.
6:00 P.M. Dinner at the Brae Burn Country Club. Informal Dress.
8:00 P.M. Busses leave the Brae Burn Country Club for Hotel Statler in time for program following the men's dinner.

ALTERNATE PROGRAM

2:00–5:00 P.M. Sight-seeing in Cambridge and Boston.
4:00–5:00 P.M. Motorboat trip on Charles River Basin leaving from, and returning to, M.I.T. Sailing Pavilion in front of Walker Memorial.

Tickets for ladies, covering Registration, Conference, Luncheon, Boat Trip, and the Ladies' Dinner at the Brae Burn Country Club, may be ordered with the men's blanket tickets at the nominal charge of $3.00. Separate luncheon tickets may be purchased at $1.50 on June 9; Ladies' Dinner tickets at $2.00.

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with HERRINGBONE GEARS

—Quiet in operation ••• for pressures up to 500 lbs.

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BROWN & SHARPE B·S PUMPS

SKEIN REELING

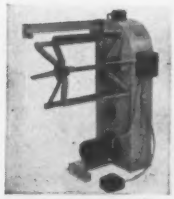
with unique efficiency

for ALL Kinds and Counts of Yarn

By this *new* twin-unit, single-operator method of skein reeling, FIDELITY machines quickly pay for themselves by savings that include time and floor space as well as cost. Result:—greater output per shift at a handsome saving—also less operator fatigue.

If increased output and savings interest you, send for Bulletin 361.

Single-end type for heavier yarns and shorter skeins; double-end type for yarns of finer count in longer skeins.



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MAIL RETURNS

Fire Protection at School

FROM EDWARD R. SCHWARZ, '23:

Mail Returns for May carries a letter from Frank L. Ahern, '14, who notes the fact that in an article appearing in the March, 1940, Review he placed emphasis on the suggestion that fundamentals of fire protection and safety engineering be included in engineering and architectural courses. . . . It will be of interest that work in safety and fire protection engineering has been offered at Technology since 1919. Until 1934 it was a fourth-year elective in the Course in Mechanical Engineering and since then has been a part of the industrial-plant engineering elective in Course II, fourth year. . . . From 1927 on, the work has been handled by me.

On page 291 of the May issue are reviews of two books in the field of fire protection engineering: One, the Crosby-Fiske-Forster *Handbook of Fire Protection*, is the standard reference work (in the earlier editions) used in the M.I.T. course; the other is the volume *Fire Defense*, which deals in large measure with arson and sabotage. As industrial vice-president of the Massachusetts Safety Council, I have organized and directed the operation of two special fifteen-week courses offered at the Institute by the Massachusetts Safety Council to groups totaling over two hundred men. In addition to the emphasis placed upon safety engineering, time was devoted under my immediate direction to a thoroughgoing discussion of fire protection engineering and the present situation in regard to arson and sabotage.

It has always seemed to me that the men taking work in building construction and in architecture should be more cognizant of fire protection and prevention and with safety engineering than they are at present. The work might well be offered as a part of some existing course or as an elective unless the present already crowded schedule would prohibit the extra hours. My one suggestion in emphasizing the matter at the present time is the considerable importance of, and interest in, the subject at the moment. Even though such elective courses might not be continued after the present emergency, consideration could well be given to handling them on a temporary basis while the emergency lasts. *M.I.T., Cambridge, Mass.*

Editors

FROM PERCY BUGBEE, '20:

This letter is to express to you the thanks of the National Fire Protection Association for the reviews of our two recent books [May Review, page 291]. The editor of the *Handbook of Fire Protection* was our technical secretary, Robert S. Moulton, '17, and the editor of *Fire Defense* was our chief engineer, Horatio L. Bond, '23. *Boston, Mass.*

THE TABULAR VIEW

(*Concluded from page 332*)

Fences. — S. PAUL JOHNSTON, '21, aviator, editor, author, co-ordinator of research for the National Advisory Committee for Aeronautics, describes with gusto the organization of America's naval aviation (page 360) in a chapter taken from his *Flying Fleets*, a volume soon to be published by Duell, Sloan and Pearce, Inc., of New York.

Figures. — The opportunities for industrial mathematics are numerous and important, as is explained for The Review (page 362) by an industrial mathematician of experience. T. C. FRY, who lectured on electrical engineering at the Institute in 1927, has been with the Bell Telephone Laboratories since 1924 and has written widely on his subject.

OXY-ACETYLENE FLAME-GOUGING
is a New Shop "Tool"

What it is:

Flame-gouging is a variation of oxy-acetylene cutting. This process removes a fully-controlled groove or "gouge" of surface metal—without harm to adjacent areas. All that you need to use for gouging is a *standard* Oxweld C-31 or C-32 cutting blowpipe, and a gouging nozzle. These nozzles are available in three different sizes to fill all requirements.

How it is used:

The most common uses of flame-gouging include:

- —Removal of faulty or temporary welds.
- —Gouging the backside of electric welds.
- —Preparing plate edges for welding.
- —Maintenance, reclamation, and scrapping.
- —Redesign of forgings and castings.
- —Preparing broken castings for repair.
- —Fabrication of parts requiring a "groove."

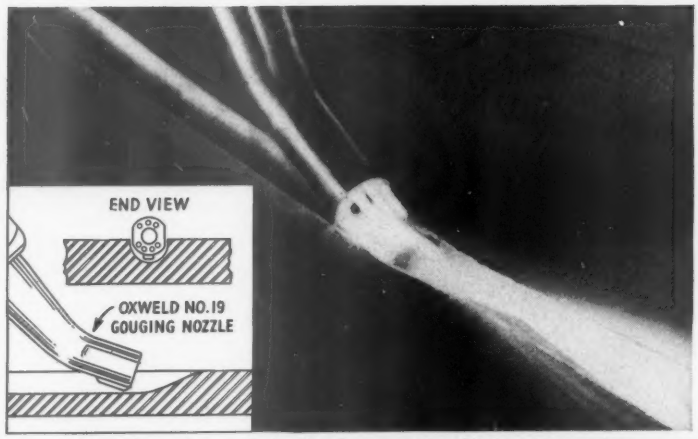
While this process has only been available about one year, its uses seem to be limited only by the ingenuity of the operator and the shop needs that arise.

What its advantages are:

In addition to use in large fabricating plants, gouging offers particular advantages for the small shop—because it can do so many things that formerly required equipment not found in small shops. Some advantages of gouging are:

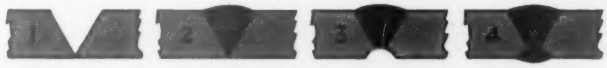
- —It reduces shop noise.
- —It is easy to learn and use.
- —It requires only a small investment.
- —It replaces expensive tools and machining operations.
- —It eliminates costly hours of grinding and chipping.

Write for descriptive literature—if you want to know more about this process, write for "Flame-Gouging, An Economical Method of Grooving Steel." A copy will be sent without obligation.



The illustration and sketch show an Oxweld No. 19 gouging nozzle making a groove ⅜ in. wide and ¼ in. deep in steel plate.

A Few Typical Uses



In the construction of tanks, a typical sequence of operations is shown above. Machine-cut plate edges (1) are welded as in (2), then gouged as in (3), for the back-up weld (4).

In preparing steel for welded fabrication, mechanized gouging with Oxweld machines is often used.

One user reported that he makes liquid-level gauges by gouging a channel in steel plate, then facing it with glass.

Studs temporarily welded on to steel pipe, to hold a testing head, were easy to gouge off with Oxweld equipment.

THE LINDE AIR PRODUCTS COMPANY

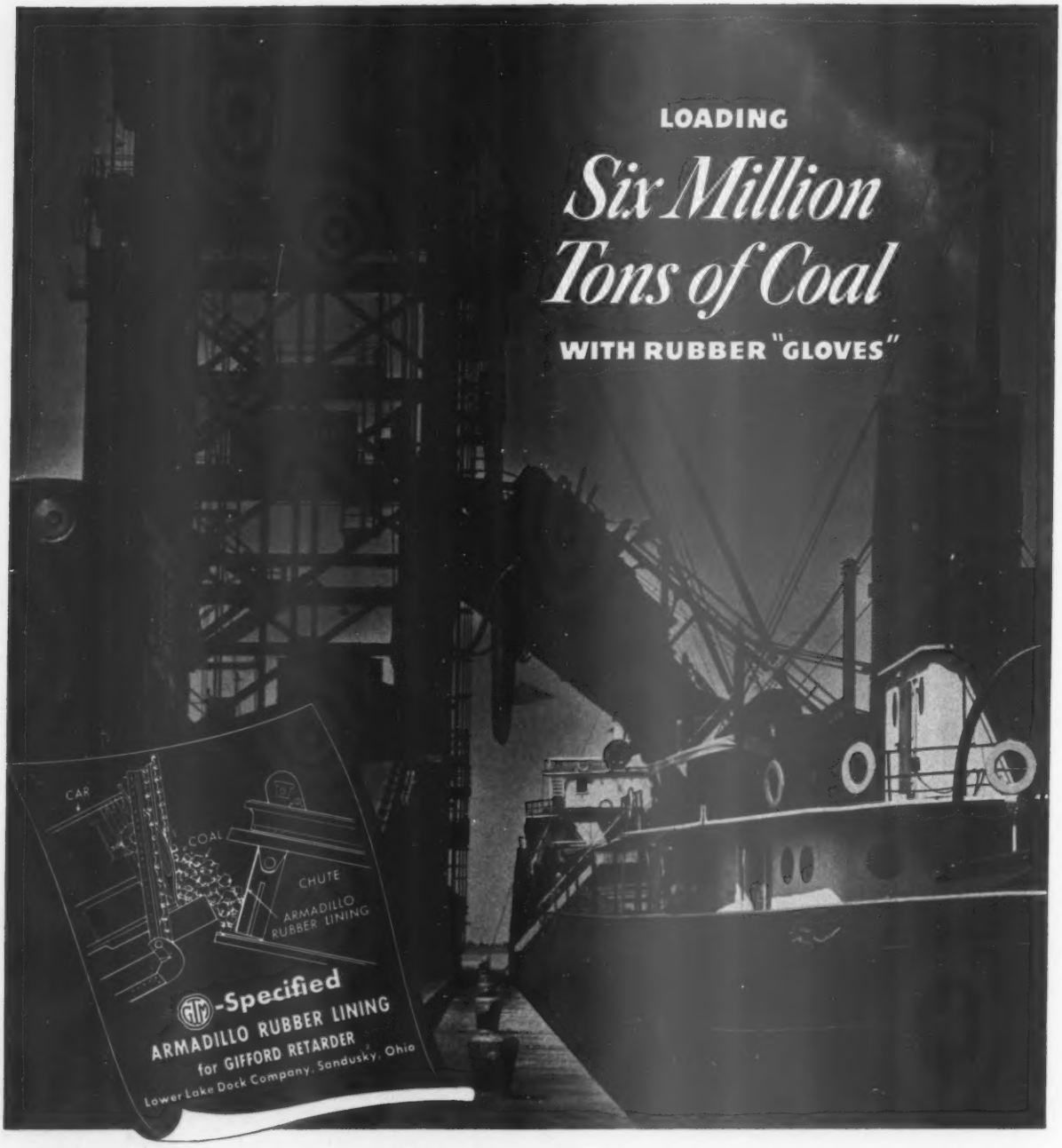
Unit of Union Carbide and Carbon Corporation

General Office: New York UCC Offices in Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, UROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.



HERE you see a great mechanical "hand" that picks up 50-ton cars of coal and dumps them into colliers. To keep the coal from smashing on ship bottoms, the dock engineer designed a heavy steel retarder which catches the coal as it falls from the overturned car and regulates its flow down the loading chute. But protecting the retarder itself from battering 50-ton impacts was a different problem. Several cushioning materials were tried, *but none lasted more than three months.* Finally, on recommendation of the G.T.M. – Goodyear Technical Man – the retarder was faced with a thick sheet of Armadillo Rubber Chute Lining, specially compounded by Goodyear for handling the most abrasive ores. It lasted *two years* – took a beating from six million tons of coal – before wearing out. And the dock company reports that this resilient "rubber glove" protection has greatly reduced coal breakage in dumping. To consult the G.T.M. on any tough material-handling problem, write Goodyear, Akron, Ohio or Los Angeles, California – or phone the nearest Goodyear Mechanical Rubber Goods Distributor.

THE GREATEST NAME IN RUBBER
GOODYEAR

P. W. Bradford

Worn wood and summer sun

VOLUME 43 NUMBER 8

THE TECHNOLOGY REVIEW

TITLE REGISTERED U. S. PATENT OFFICE

EDITED

AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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"Javanese Orchid," by the late John Skara, associate of the Royal Photographic Society

THE
TECHNOLOGY
REVIEW

Vol. 43, No. 8 June, 1941

The Trend of Affairs

By Water Inland

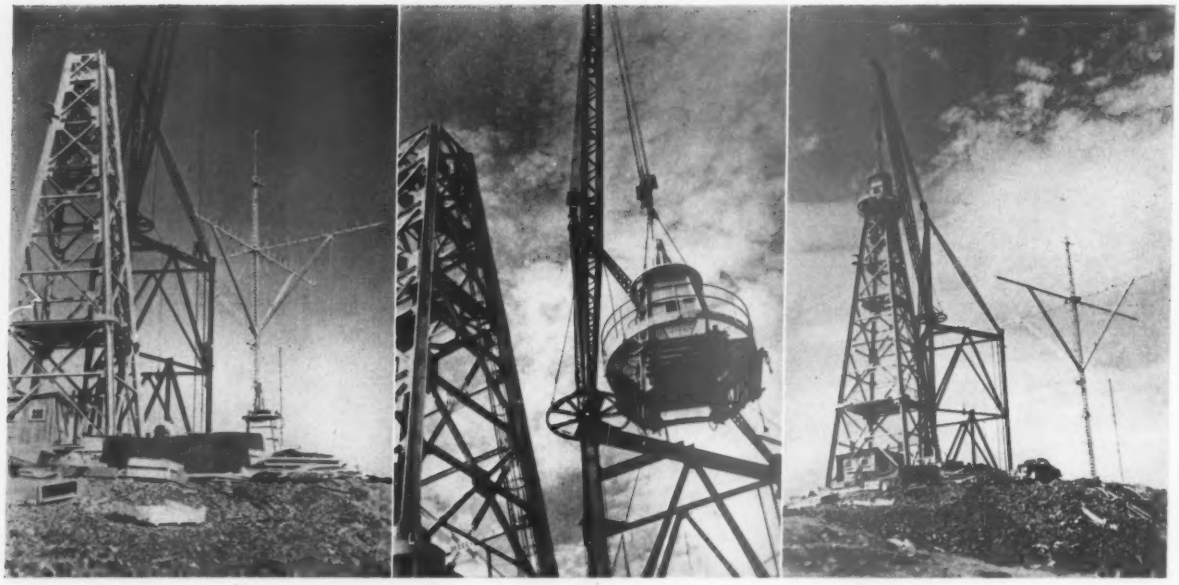
ALONG the shores of the Gulf of Mexico is a little-known waterway extending, save for two short gaps, from Corpus Christi, Texas, to St. Marks, Fla., and affording inside passage for shallow-draft vessels for a distance of 1,009 miles. One of the missing links, that between Freeport and Port O'Connor, Texas, is now under construction and will be completed next month; the other, that between St. Marks River and Carrabelle, Fla., is held up pending settlements with landowners. The entire course, which is called the Gulf Intracoastal Waterway, has existing natural depths or has been improved to afford a depth of nine feet at mean low water over a minimum bottom 100 feet wide. On its waters will float heavy barge traffic, cargoes of crude oil, refined petroleum, iron, steel, sulphur, and, in the east, pulpwood for fast-growing southern mills. The project is described with characteristic modesty in a publication, "The Gulf Intracoastal Waterway," by the Corps of Engineers, United States Army, who built it.

Such a highway has been badly needed. The Gulf of Mexico is notorious for its squalls, which often destroy small craft at but a short distance offshore. Since the first settlers, the numerous bays have been used for protected passage, a tendency which was strengthened because the marshy coast made other modes of transport slow to develop. A project to facilitate water transportation along the gulf engaged the interest of Congress as early as 1828, when $18,000 was appropriated for the construction of a Mobile Bay–Mississippi Sound channel. Improvement of Lake Pontchartrain was first authorized in 1852. Subsequently a number of acts of localized importance continued the development work until Rivers and Harbors acts of 1925, 1927, 1930, and 1935 permitted the completion of the project. Many details have necessarily been closely related to the Mississippi flood-control projects, also a charge of the Engineers.

In a quiet way they have dredged and now maintain this channel which, west of New Orleans, skirts bays and sounds that are generally shallow and subject to shoaling; this section has many canals. East of New Orleans, open bays and sounds are followed wherever possible. The route passes through the flat coastal regions of Texas, where one can see for miles, and on through Spanish-mossed bayous of the Evangeline country, where the waters are catfish infested. It passes indiscriminately through fields of oil, pecans, cane, or corn. Navigation is free except for one lock at New Orleans.

At the eastern end, the waterway will, when finished, join with an already constructed canal across Florida (not the one of much controversy). This in turn will carry the inland passage to the Atlantic Intracoastal Waterway, also an Engineers' project. Thus inland passage from Corpus Christi to Boston will be made a practicable thing.

Among the most interesting links in this system is the Florida crossing. This job started as a conservancy project. Lake Okeechobee, which it joins to the Atlantic and the gulf, is the dominating factor of the Everglades. Thirty miles across, 18 feet above sea level, the lake can be whipped to much higher levels by hurricanes or rains, can be depressed by droughts. When the lake is high, the Everglades, which constitute the most conventionally "tropical" region in the United States, are flooded; when the lake is low, they literally burn up, ravaged by underground fires similar to those which destroy peat bogs. This is a pity because the Everglades are naturally very fertile, many of the islands being covered with wild plants. From them can come three to four crops of vegetables a year, much sugar cane, much fruit.



The construction of an experimental wind turbine to generate electricity on Grandpa's Knob, a Green Mountain peak near Hubbardton, Vt., proceeds steadily, as the photographs on these pages show. The above series presents the raising of the tower cap, on which the main mechanism will rest and about which it will yaw with the wind. The top of the cap is 110 feet above the ground. The three structures shown are, from left to right, the turbine tower, the temporary erection derrick, and the 180-foot anemometer mast. Many Institute Alumni and staff members have shared in the research which preceded initiation of the project. (See The Review for December, page 59.) The function of the turbine is to drive a 1,000-kilowatt generator. Wide industrial applications for wind-generated electricity are anticipated once its low-cost availability has been demonstrated by experimental installations such as this.

Long ago the state of Florida built a number of drainage canals from the lake, but they often choked up. In the interest of better conservancy, the Engineers have leveed the entire southern lake shore and, after long studies, have developed the desired lake levels for various times of year to keep a safe stage both for flood and for drought, these stages being maintained by channels, levees, hurricane gates. Incidentally, in so doing, the Engineers have provided a channel across Florida to the gulf.

From Fort Pierce on the east shore, the approach to the lake is straight and through savanna-covered lowlands. A lock raises the canal to lake level. From the lake westward to the gulf, the course follows the Caloosahatchee River, which was a meandering stream lined with big trees and orange groves, teeming with birds. Some of the bends have been straightened out, but the river maintains much of its original beauty.

Projects like these are not so dramatic as some efforts, such as the Tennessee Valley Authority — for which, incidentally, the Engineers made the preliminary studies. In the long life of a nation, projects such as the Intracoastal Waterway may mean more. It is not the habit of the Engineers to prate of their accomplishments or of what they are about to do. But it should be a source of some comfort that they continue to do and to do well. It was they who built the Bonneville Dam and handled the Pittsburgh flood control. Longer ago, of course, they built the Panama Canal and the Alaska railway. As a matter of fact, they built most of the Washington Monument. The observant will note a change in color of stone on the obelisk about one-quarter of the way up. This change notifies him where the Engineers took hold. At that point in construction the monument began to settle, and the Engineers were brought in to underpin and complete the pile.

All this is of some importance in view of the fact that in the current year the Corps of Engineers will have the largest construction program in their history, totaling over a billion dollars. Much of the money will be spent for the Army Air Corps, as the Engineers have the directive for the construction of all airports. In addition, they are to build the Atlantic island bases at Newfoundland, Bermuda, Trinidad, Jamaica, St. Lucia, Antigua, British Guiana, the Bahama Islands, and, one supposes, Greenland as well, where reconnaissance may even now be going on. The total of these items is eight hundred million. One hundred eighty-seven million more will be spent on rivers and harbors and on flood control. The Engineers are deepening channels at Norfolk and in the Delaware River at the request of the Navy, while flood-control works in the Ohio and Connecticut river valleys will protect important industrial plants.

All this work is done without fuss and flurry, without publicity, in practical anonymity. Here is no great engineer, but a great corps of engineers.

A Word for It

NOT the least remarkable feature of a specialist, be he surgeon, safecracker, or surveyor, is his private language, the one he reserves for his technical peers. To a large extent, of course, technical dialects are unavoidable; experts must discuss things and concepts which are new or beyond the ken of the layman. There-

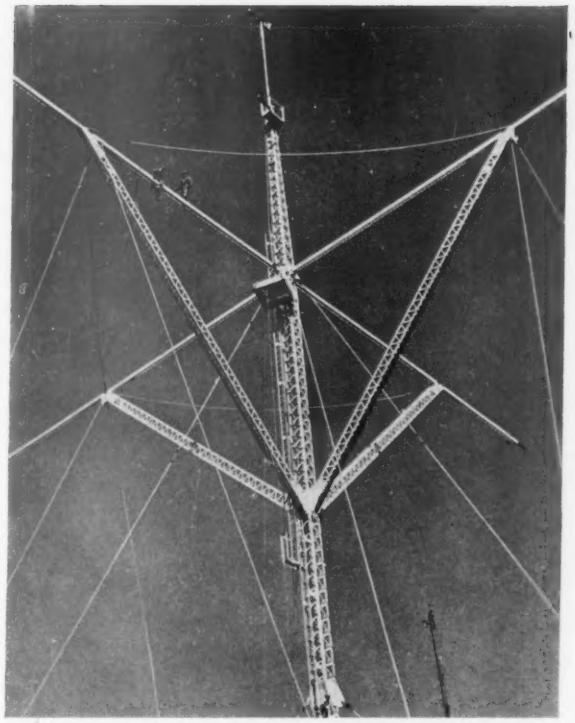
fore they invent new words or give highly specialized and limited meanings to old ones. Barring some argument about the choice of the verb, how could a doctor say in better fashion that "Desoxycholic acid elicited transplantable subcutaneous fibrosarcoma in a high proportion of the mice and rats injected"? Or how could the language of patent claims have been carried to its apex of precision without formalization of phrasing and structure, and definition of every "and" and "or" by court decision? On the other hand, to a miserable layman it does seem that some better way could have been found to say that "If a stationary observer determines the time by measuring the rest-mass of sand flowing through an hour glass at rest at the origin, then the moving observer must be assumed to determine the time as the rest-mass of sand flowing through an hour glass, indistinguishable from that used by the stationary observer, and moving with the moving observer's origin." It helps to read this over at half-hour intervals.

Since experts as a rule talk only to experts or to authorities (authorities are people to whom experts go when they are stymied), they can afford not only to use special words but also to abbreviate. Thus a doctor may casually mention that he just "did a chronic appendix," or an engineering journal may report that "CBS has built new station for KNX." And even amateur photographers talk learnedly of *f*/ and "gamma."

Finally, because experts are also human and therefore a little vain, they are not above throwing in a word now and then just to impress the home folks. Something of the witch doctor still persists in all practitioners of esoteric skills, some instinctive attempt to gain respect for their calling by using a little mumbo jumbo to daze the outsider and leave him (they hope) feeling properly awed.

But even with abbreviations and razzle-dazzle eliminated, science still appears to be tough reading. David P. Boder, who measured the ratio of adjectives to verbs in various types of writing, concluded that the fewer the adjectives the easier writing is to read. By this standard, scientific writing is at the bottom of the list: Compared with plays, which have on the average about eleven adjectives for every hundred verbs, and with fiction, which has perhaps thirty-five, the pronouncements of scientists qualified themselves to the extent of seventy-five adjectives per one hundred verbs.

Here is one of the turbine blades in transit. The blade alone weighs some 15,300 pounds. The assembly here shown weighed about 35,000. When the blades are hoisted into position on the turbine tower, added assemblies will make the final lift for each of them about 50,000 pounds. The blade is 65 feet 7½ inches long, 11 feet 5 inches wide. The diameter of the two when mounted will be 175 feet.



The anemometer mast, 180 feet in height, will be used for special studies of vertical wind gradients and of gust gradients along three co-ordinate axes. Spaced along the vertical mast, five rotor anemometers of a new type, heated to prevent ice formation, and five ordinary cup anemometers will give the vertical gradients. Seven pressure anemometers of special type, including four heated ones mounted on the tips of the crossarms, will give gust gradient data. A static orifice and a wind indicator will also be mounted on the mast. Readings from all these instruments will be transmitted electrically to a panel board in the control house and will be photographed by a motion-picture camera to give a continuous record.

Attack on High Blood Pressure

HYPERTENSION, better known to laymen as high blood pressure and too often dismissed as a state of health rather than a disease which holds first place as a cause of death, takes more than 375,000 lives a year in the United States alone. This is more than twice the death rate of cancer. Ninety-five per cent of the cases of high blood pressure are now attributed to diseased kidneys. After many years of intensive medical research, encouraging results in the treatment of hypertension have been achieved by experiments with an extract derived from the kidneys of cattle.

The announcement of this advance was made with proper reserve by Dr. Irvine H. Page, director of the Lilly Laboratory for Clinical Research, at the recent annual meeting of the American College of Physicians.

The possibility of developing a method for reducing high blood pressure rests upon the discovery that in the kidneys of animals and man a substance called "renin" is produced. This substance, combining in the blood stream with a chemical designated as an activator, produces a third substance which has been named "angiotonin."

Dr. Page's report suggests that the properties of angiotonin may be the chemical cause of high blood pressure, but he cautioned that further investigation will be necessary to determine whether angiotonin is the chemical *saboteur* in hypertension. The kidney also produces a substance which counteracts angiotonin, lowering blood pressure in hypertensive organisms. When a kidney becomes diseased, however, its secretion

John H. Gerard

Two green herons at the "leaving nest" stage demonstrate that Nature has a sense of humor.

of renin is believed to outbalance its secretion of this inhibitor of hypertension. As a consequence, the excess renin leads to the production of an excessive amount of angiotonin. The small blood vessels are then affected by the angiotonin in such a way that resistance to the flow of blood is increased and blood pressure is consequently raised.

This observation led to the preparation of an extract from which the blood-pressure-raising precursor, renin, is almost completely eliminated, the extract having a concentrate of the kidney substance that lowers blood pressure. After careful trials on laboratory animals, the new extract was administered to nineteen persons suffering from extreme forms of high blood pressure. Nine had malignant hypertension, an acute form which usually causes death within two months. Of this group of nine, only two have died, and the blood pressures of the remaining seven have been kept at approximately normal for periods extending up to a year in duration. The remaining ten cases treated with the new extract were afflicted with the disease known as "essential hypertension." While not so serious as the malignant type, this form is one of the most deadly of man's diseases. All the patients in this group are still living, their blood pressures reduced nearly to normal. Although Dr. Page considers the results distinctly encouraging, he said that the problem of producing the kidney extract in quantity has not yet been solved and that at present the extract cannot be made generally available to the medical profession.

Renin, he explained, is a protein produced in the normal functioning of the kidney. The activator that converts the renin into angiotonin is a protein produced by the liver. With the removal of the liver of an animal, the angiotonin disappears from the blood stream.

Angiotonin, Dr. Page said, has been produced in the crystalline form necessary to permit chemists to determine its chemical structure and composition. This is the first essential step toward creation of the substance synthetically. Dr. Page revealed that investigations are now in progress to determine the composition of the angiotonin molecule and the arrangement of its atoms. In this study lies the hope that science may synthesize a chemical molecule that will neutralize or counteract the action of the angiotonin, just as the substance produced in the normal kidney inhibits the action of this chemical.

Control of high blood pressure has long been one of the major goals of medical research. A few years ago a kidney extract called "tubulin" was reported by Dr. Benjamin Jablons of New York. Further tests with the new kidney extract described by Dr. Page will be necessary to substantiate the promising preliminary results. Meantime, research for a method of producing the extract in quantities sufficient to make it available on a large scale will go forward.

Heating with Light

THE heating lamp your doctor used on your lame arm to "bake out" the pain has become a respected citizen of industry. Easily one of the most revolutionary processes of the finishing industry, heating with incandescent-lamp bulbs (now generally and popularly known as "infrared heating") has come to be one of that industry's rapidly accepted aids to defense speed-up. Drying times have been sharply reduced, in some instances to as little as 1/100 of their former air-drying exposures. Patented a mere six years ago by the Ford Motor Company, the process has been adopted in countless large and small industries throughout the country, installed wattages varying from 1,000 to 22,000.

Applications for the new drying marvel are numerous. It is used to dehydrate plastic molding powders and plywood sheets before the molding operation, to dry printer's ink, to soften plastic materials, to dry the inside of caskets, to dry photographic films, to pre-heat embossing rolls, to cure hams, to bake bread, to accelerate the setting of cements, and to bake or semibake

Allan D. Cruickshank

A white ibis shows off his retractable landing gear.

a wide range of lacquers and synthetic enamels. Whenever a small-to-moderate amount of heat is desired for speeding up a sluggish chemical reaction in any industry, particularly when the purse strings must be tightened, the use of infrared heating has gained quick recognition. At least a dozen manufacturers supply bulbs, reflectors, and "ready-to-wear" equipment, and, in addition, make all the necessary specifications by testing the customer's product in their master ovens and guaranteeing the results in advance.

Basically, the method takes advantage of the fact that 90 per cent of the energy emitted from an incandescent lamp is in the region of the infrared wavelength. By burning the lamp at about 10 to 15 volts below rated voltage, the user gets rid of some of the remaining 10 per cent of visible light and immeasurably prolongs the life of the lamp. This abundant radiant energy is directed, by a reflecting arrangement, onto the user's product and "goes to town" — without appreciably heating the intervening air — in exactly the same fashion as Old Man Sol performs his daily work. With the necessity for expensive insulation and enclosures eliminated — not to mention the absence of electrical windings and controls — the user of infrared is delighted to find that his installation cost is a mere fraction of that of a modern oven designed to do the same heating job.

A curious fact brought out by the development of this method is that incandescent-lamp history evidently repeats itself, much as does political history. Tungsten replaced carbon as the filament in Edison's original lamp because of the greater color temperatures — and thus the greater light output — obtainable with the metallic filament. When lamps are used for heating, however, light output is not the most important consideration and therefore the first bulbs for heating were made with carbon filaments. Subsequent tests showed that tungsten was fully as satisfactory if operated at reduced voltage. Hence the shift is now toward tungsten filaments because the carbon users have encountered Edison's old difficulty — early blackening of the bulb from carbon evaporation.

Scientific examination of the principles of this form of radiant-energy heating has lagged behind the commercial acceptance of the process, as often happens when practicability is so readily demonstrated and eager ears are listening. First myth to be exploded in research studies of the past year or two was the theory that the acceleration of drying is due to the phenomenon of "baking from the inside out." A simple test, in which a panel was painted on each side but irradiated on only one, showed that both coats were equally cured and that temperature alone must therefore be responsible. Talk about the "mysterious penetrating powers" of infrared energy, impressive as it may be to the romantically minded, thus does not survive the elementary test of plain practical experiment.

Generally accepted at present is the belief that rapidity of cure is achieved by the quick temperature rise and the higher maximum temperature attainable with this new heat source. This theory is borne out particularly with the synthetic resins of the alkyd and urea-formaldehyde types, the finish of which will set almost instantaneously when a critical temperature is reached. Because heat is poured simultaneously into the entire film, this scheme prevents skinning over of the surface layer and thus removes one of the chief obstacles to rapid all-out cure.

Cornelius Denslow

Ah, there, have an apple?

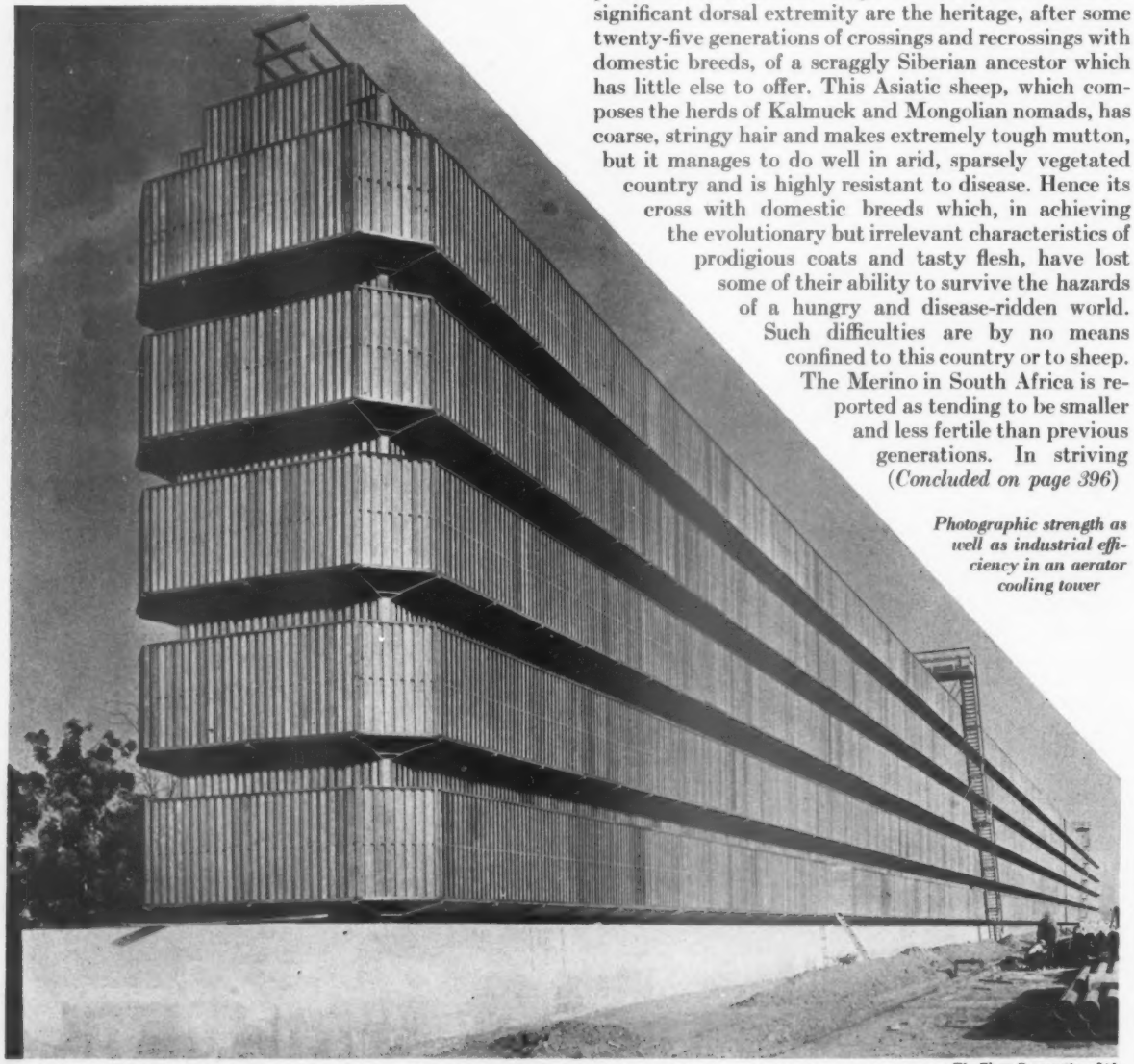
A particularly encouraging note pointing toward establishment of a firmer scientific basis for the design of drying tunnels is the recent recommendation of the Utilities Research Commission, Inc., that paint manufacturers adopt a new method of specifying the drying times of their products. Instead of stating, "This paint dries in 1 hour at 300° F," the commission would have the label read, "This paint dries in 10 minutes in a radiant energy density of 2.5 watts/sq. in." Tunnel design would thereby be considerably simplified, since instruments are available to measure infrared density, and performance is predictable on the basis of efficiency values now fairly well established for bulbs and reflectors. Present methods of stating drying times make laboratory studies necessary in most new installations.

The imagination persists in wandering when any effort is made to sight the horizon for infrared heating. One can easily cite dozens of daily heating tasks that might be more simply (although, at the present time, probably more expensively) performed with incandescent-light bulbs. If hams have been cured and bread has been baked industrially by this method, it is not beyond belief that the housewife should find convenient applications. A small portable unit might be wheeled around in one's cellar, for example, to hurry the drying of the weekly wash when the weatherman frowns on outdoor exposure. Eggs could be "boiled" dry with a single lamp setup. A simple device, utilizing an ordinary automobile headlight bulb as a heat source and concentrating the rays at the tip of a cigarette, will ignite the tobacco in a much quicker time than it takes to fumble with a match case.

Functional Overstrain

A NEW breed of sheep, with strong wool, a tough constitution, and a short or completely absent tail, has been announced by the South Dakota Agricultural Experiment Station. The tough constitution and the insignificant dorsal extremity are the heritage, after some twenty-five generations of crossings and recrossings with domestic breeds, of a scraggly Siberian ancestor which has little else to offer. This Asiatic sheep, which composes the herds of Kalmuck and Mongolian nomads, has coarse, stringy hair and makes extremely tough mutton, but it manages to do well in arid, sparsely vegetated country and is highly resistant to disease. Hence its cross with domestic breeds which, in achieving the evolutionary but irrelevant characteristics of prodigious coats and tasty flesh, have lost some of their ability to survive the hazards of a hungry and disease-ridden world. Such difficulties are by no means confined to this country or to sheep. The Merino in South Africa is reported as tending to be smaller and less fertile than previous generations. In striving

(*Concluded on page 396*)



Photographic strength as well as industrial efficiency in an aerator cooling tower

The Fluor Corporation, Ltd.

Present Pleasures or Future Benefits?

Willingness to Make Sacrifices Is a Hallmark of the Character Essential to a High Standard of Civilization

By Karl T. Compton

SCIENTISTS, engineers, and inventors have created the so-called technological age. We believe that our work and its results are predominantly beneficial to mankind. Some timid souls are frightened at the pace with which technological achievements have come; some see our creations being put to destructive use in warfare and feel that man should not be allowed to have such powerful tools; still others worry about the unemployment that frequently results from introduction of laborsaving machinery or from replacement of one product by a superior one. We technologists, while admitting both accidental and premeditated harmful effects of science, nevertheless see the gains from technology as far outweighing the losses, and we have sure faith in the social value of our efforts.

We see such advances as improved homes, better wages, shorter hours of work, far less disease and suffering, free time for education during youth and for vacations during working years, and, finally, pensions in our old age. None of these happy situations ever existed in the history of the world for the masses of any people until science and its applications made them possible. Just for one illustration consider this tremendous fact: It has been estimated that during the past three hundred years the population of the earth has increased three times as much as in all the preceding hundreds of thousands of years of man's life on this earth. Knowledge of medicine, disease, and health; more fruitful methods of agriculture; methods of fast communication and transportation have combined with other technological factors to push back the starvation, epidemics, infant mortality, floods, and other hazards which were continually limiting the earth's population. Whether we like the fact or not, about 1,500,000,000 people are alive today who would be dead or unborn except for modern technological progress. Since that figure includes two or three out of every four persons among us, I imagine that if we were to vote on the subject, most of us would be in favor of keeping and further extending the technological progress that has made these things possible.

Volumes have been and can be written on the effects which technological progress has had on human life. But this is not my real subject; I have mentioned it only because it forms a background for the thought that I should like to develop.

We like to think that our technological progress has brought us to a high stage of civilization. Is this thought really true? Technological progress certainly has brought us the things that go to make up what we usually call a high standard of living. But does a high standard of living mean the same thing as a high standard of civilization? I think not; a high standard of living is only part of the picture and perhaps the less important part.

For example, imagine a race of technological supermen whose knowledge of the forces and materials of nature greatly exceeds ours of today and who are incomparably clever in invention, quantity production, distribution of goods, and all that. Suppose by working only one hour a day they can produce and have more than we ever thought possible in the way of food, home furnishings, entertainment, comfort, and health. They would have what we call a high standard of living. But the products of their technological ability would not in themselves make a fine civilization, for these supermen might be soulless creatures with no appreciation of beauty, no affection, no sportsmanship, no control of passions. They might be utterly ruthless and without integrity, honor, or altruism. Despite their technological ability, their civilization under these conditions would be not fine but terrible.

The point which I seek to make is, of course, this: As we commonly use the terms, "standard of living" involves material things and services, whereas "standard of civilization" involves, in addition, a foundation of character and of ideals. Perhaps we can put the matter this way: Possession of scientific knowledge, engineering proficiency, and inventive skill gives a man increased power but does not in itself make him a better man. He may still be a valuable member of society or a destructive gangster, and technology simply makes him a more valuable member of society or a more destructive gangster. Similarly with a nation — technological progress brings greater power for good or evil, depending on whether the preponderant character of the people is kindly and constructive, or selfish and aggressive.

Much truth is contained in the statement that the degree of civilization of a people can be measured by the extent to which they are willing to sacrifice their present pleasures for the sake of their future benefits. To whatever extent this statement is correct, it places the emphasis upon wisdom and character. Measured by this yardstick, a good many of our actions as a people, whether in our individual communities or in our nation as a whole, cannot afford us pride.

For instance, when a city or a state or a nation goes into debt year after year for the sake of providing benefits to this or that pressure group, government is handicapping future welfare for the sake of present gratification. This, I believe, is one of the prevalent situations in this country which indicate that we have not reached

a very high stage of civilization in our basic thinking and character, however well we may be supplied with the gadgets and appurtenances which add to our comfort and our ability to achieve our purposes. Of course in certain circumstances it is legitimate and necessary to go into debt, as in times of unusual emergency. Such a time is certainly the present, when we are under not only a threat of possible war for our own defense but also a moral compulsion to aid others in the defense of those social ideals which we and they have struggled for centuries to secure. In the absence of such unusual emergency, however, we have to recognize the fact that mortgaging the future for the benefit of the present is so easy that we are more than likely to slip into this unwise attitude unless we are constantly on guard.

Another evidence of the lack of wisdom and character which indicates that this country and the other countries of the world are still at a rather elementary level of civilization is found in the various stages by which the nations have drifted into the present desperate mess. If it were not so tragic, a review of the various milestones in international events of the last twenty years would read like a comedy of errors. At the end of the World War, two theories prevailed: one, to have "peace without victory"; the other, to carry the struggle through to a definite victory. Either of these theories if logically pursued might have been satisfactory.

What was actually done? The War ended by an armistice, with the Allies feeling that they had won a victory although the Germans never admitted that they were beaten. In the Treaty of Versailles conditions were imposed on Germany as on a vanquished nation — conditions which were designed to break her power to disturb world peace again. Next came the League of Nations, a noble ideal to place international affairs on the same basis of law and order as community affairs are placed within one state or united states. Our own country, which had entered the War with the slogan "To make the world safe for democracy" and which had expended billions of dollars and thousands of lives to that end, suddenly shrank from the responsibility of playing her part in this post-War effort. Whether because of fear or selfishness or shortsightedness or a combination of these factors, I do not know, but certainly our own country by her passive attitude did more than her share to wreck the inherent possibilities of the League of Nations and to open the way for the catastrophe which has now again engulfed us.

The Manchukuo incident was the first in the series of international aggressions which finally led to a situation so intolerable as to provoke the present war. At the time of Manchukuo it was Great Britain, and not the United States, which was unwilling to take the firm stand that undoubtedly would have nipped in the bud this renewed tendency for international aggression. Japan, having succeeded in her first aggressive effort, was encouraged to proceed farther into China; Italy was encouraged to proceed into Ethiopia; Germany was encouraged to push her domination to the east. And step by step the situation grew worse.

Germany's first step was to engage in an extensive program of military preparedness, contrary to the terms of the Treaty of Versailles. Unwillingness to face squarely the potential dangers in this action prevented Great Britain and France from taking steps to control the situation. The next step was Germany's march into the Rhineland, a zone which had been set up as a protection against aggression on that border. Again, wishful thinking on the part of Great Britain allowed Germany to get away with this move. Thus a Germany, bitter with the feeling of the injustice of the Versailles Treaty, was permitted step by step to gain a position of military strength whereby she became once more a threat to the peace of the world.

The tragic feature of this whole history is the fact that the nations which had the power to control events did neither one thing nor the other with decision. Had Germany been generously treated and had the victors of the last War been willing to make some sacrifices for Germany's benefit, it is entirely probable that a program of pacifism and international disarmament could have been carried forward successfully, beneficially, and safely. On the other hand, had the victors consistently held to a policy of enforcing the terms of peace, it is very doubtful that the peace of the world would now be broken. Self-interest, wishful thinking, and lack of willingness to take unpleasant steps in order to safeguard the future all combined to bring the world again into destructive war.

One after another, states have lost their freedom and become subjected to terrible economic and physical hardship because they were unwilling to believe what would happen to them if they remained neutral against the growing aggressive march of nazism. The doctrine of pacifism, idealistic enough in itself but not facing the reality of the situation, had lulled them into insecurity and unpreparedness. In the light of what has happened to them, is there any doubt that if they could set back the march of time by eighteen months or two years and could make their decisions over again, they would forsake their reliance upon isolationism and would band strongly together for common defense against the aggressor?

Our own attitude in the United States has been strikingly similar to that of the countries which I have mentioned, with the sole exception that the broad expanse of the Atlantic Ocean and our potential strength have served to protect us. But even if she is successful in her present struggle against Great Britain, Germany will be a country in desperate economic plight when the war is over. In such circumstances and with a knowledge of the ruthless methods which she follows to her own advantage, is there any question that she will use every weapon at her command, whether military or economic or fifth column, to break the economic power of the United States and secure by fair means or foul as much as possible of our wealth? In the face of this situation, what has been our attitude?

The first reaction of the country was to build a wall around ourselves, shut our eyes to the realities of conditions in the rest of the world, and hope that we could work out our own salvation. That such a policy is unwise and impossible has become clear. We have now entered into a program for increasing our national defense, but even this we undertook in the early stages in a less than halfhearted (*Concluded on page 370*)

Cy La Tour from Petroleum World

Oil and the Axis

Germany's Supplies of Petroleum Products Are Not Generous, Analysis of Her Sources Shows; Synthetic Plants a Crucial Element in the Situation

By Robert E. Wilson

BOTH the strategy and the tactics of the present war are increasingly being determined by the quantity and quality of the petroleum supplies available to, or desired by, the various powers. A vital difference exists between the relationship of petroleum to warfare in this country and its relationship to warfare among the Axis powers: Germany and Italy are carrying on their war operations in addition to the industrial, agricultural, and civilian activities of their own nations and the occupied territory of western Europe, with a total production of petroleum products, including synthetic compounds and imports, equal to only about 5 per cent of this country's production of crude petroleum, or our consumption of products refined from petroleum.

Even the gigantic expansion program being carried out for American defense, including a two-ocean navy, a vastly augmented air force, and the large-scale mechanization of our land forces, does not greatly alter the comparison. Such a program sounds as though it would have a tremendous effect on the petroleum industry of the nation. Actually, when measured against the background of the size to which the industry has grown since the World War, the effect is relatively small. The purely military demand to date has not, in fact, offset the loss of exports due to the present war. The increasing drain, however, is making itself more and more felt as the year progresses, with substantial growth in industrial demand and in civilian demand from the new employees of industry. In the absence of war the 1941 domestic claim on petroleum is estimated at 8 or 9 per cent in excess of the 1940 claim. In the event of war the demand for the major products would be increased toward the end of the year by an estimated 5 per cent. In my opinion, no industry of comparable importance to the national defense effort exhibits so few even potential bottlenecks as does the petroleum industry.

Above:
Reflections in an oil sump in the Montebello field in California

To evaluate the petroleum supply situation of the Axis powers today, one must start with the world distribution of crude-oil production. The rather surprising figures are set forth by appropriate subdivisions in the table which follows.

1940 Crude Oil Production by Areas *

	Barrels a Day	Per Cent of Total
United States	3,692,000	63.0
Other Western Hemisphere	866,000	14.8
Russia	593,000	10.1
Near East	335,000	5.7
Netherlands East Indies	166,000	2.8
Rumania	118,000	2.0
Germany,† Poland, Albania, Japan, Hungary, and France	43,000	0.7
Rest of world	49,000	0.9
	5,862,000	100.0

* Basic data from *World Petroleum*, February, 1941.

† In addition, German synthetic production at the outset of the war is understood to have been about 65,000 barrels a day, equivalent to 1.3 per cent of world production.

The preponderance of American, British, and Dutch control of crude production is generally known, yet I think many will be surprised at the tremendous discrepancy between our 63 per cent of world production and the Axis total of 0.7 per cent. Our own figure is undoubtedly closely related to the fact that we have 68 per cent of the world's motorcars. With the exception of Rumania, European production of petroleum is negligible, and, even including Rumania, the crude-oil production of continental Europe west of Russia is only about 25 per cent of its normal peacetime consumption. Though we hear frequent references to the oil wells of Germany, Poland, Hungary, and Albania, the total production of all these countries in 1940 was only about 35,000 barrels a day, or about 0.5 per cent of world production.

We must not suppose, however, that Germany entered the war with less than half of 1 per cent of the world's petroleum under her control and without having several means in sight to augment her supply. Before the war Germany and France each required about 150,000 barrels of petroleum products a day, and about 75 per cent of France's requirements were in the territory now occupied by Germany. Italy used 60,000 barrels a day, and the other occupied territory of western Europe (not including any of the Balkan countries) brought the total pre-war consumption of this area to about 430,000 barrels a day. Under pre-war conditions, over 80 per cent of this oil came into western Europe by tanker. As against this demand, Germany has several different resources, which I shall discuss separately. Figures from this point on are of course considerably less accurate than those previously discussed. Nevertheless, various sources of information are in rather good agreement, except as I shall indicate.

(1) *Controlled crude production in western Europe.* The total daily 1940 crude production of Germany, Hungary, Austria, Alsace, and Albania — the territory directly controlled by the Axis powers — appears to have been practically the same as in 1939; that is, about 25,000 barrels, a figure not far wrong for 1940 and probably for 1941.

(2) *Synthetic oil and gasoline production.* Total synthetic oil and gasoline production (including benzol from coke ovens to the extent that it was available for motor fuel) was between 60,000 and 70,000 barrels a day at the outbreak of the war. About 70 per cent of the synthetic was made by hydrogenation, the chief base being lignite plus some coal and some coal tar. The hydrogenation process makes good gasoline, and most of the plants can be operated in such a way as to make fairly good aviation gasoline, though to do so reduces their capacity. The aviation gasoline can be leaded up to about 90 octane but is still seriously inferior to the 100-octane quality which we can supply.

The Fischer-Tropsch process, which was responsible for somewhat more than half of the remaining synthetic product, starts from coke and makes very inferior gasoline, good Diesel fuel, and some wax. The wax and the gas together can be used as the starting point for the synthesis of lubricating oils, but this synthesis is very difficult and no substantial amount of capacity appears to have been installed.

Although the figure of 65,000 barrels a day must be very close to correct for the production of synthetic substitutes at the start of the war, developments in that field since 1939 are increasingly difficult to estimate. Plants which were at that time under construction would bring present total capacity to around 100,000 barrels a day, and a few more plants may have been built without becoming generally known. Daily newspaper reports, however, bear witness to the fact that synthetic oil plants and oil-storage facilities are the favorite objectives of British bombing attacks. These attacks must have done considerable damage, though persons familiar with the spectacular appearance of a small oil fire will discount even the most honest reports by aviators about great fires observed. And it must be remembered that intensive bombing attacks on these objectives have been carried out only since last October. These high-pressure plants with much complicated piping carrying flammable products seem ideal bombing targets. The fact that they do operate under such high pressure, however, means that their principal parts must be made of something like plate armor, so that either a lucky hit at a vulnerable spot or a direct hit by a large bomb would be necessary to cause damage requiring a long time for repair. On the whole, if England's bombing has kept Germany's total synthetic production down to 70,000 barrels a day, I should consider the feat remarkable, and 80,000 barrels a day seems to me a better guess at present effective capacity — though a guess it admittedly is.

(3) *Imports from Rumania.* Rumania's production of crude has steadily declined since 1936, mainly through the gradual exhaustion of the older fields and through lack of new discoveries of importance. Average production at the end of 1940 was about 20 per cent less than for 1939 and 40 per cent lower than for 1936. The drop seems to have been largely due to increasing state control and the threat of war, both of which acted to discourage wildcatting and new development. Only seven wildcat wells were completed in 1939. Rumanian production averaged about 125,000 barrels a day for the first nine months of 1940, but latest reports indicate a drop to 100,000 barrels a day near the end of the year.

Since Rumania consumes only about 40,000 barrels a day, Germany seems now to have a very large and convenient source of oil under (*Continued on page 370*)

Composition in Photography

Remembering That Composition Is the Presentation of an Idea, the Photographer Will Come Nearer Completeness in What He Undertakes

By Paul J. Woolf

WHETHER photography is art or merely mechanics is a question widely fought but hardly worth the fighting. Photography is a technique, a business, an esthetic expression, a science — and a lot of fun for a lot of people. So it seems to me that there is little use in splitting hairs about where art stops and something else begins, or even over where photography stands in relation to that impalpable boundary line. Anyone who is by nature a gadgeteer is inclined to get his share of pleasure from the extensive and ingenious paraphernalia of the camera rather than from the capturing of beauty or significance, for which the apparatus has presumably been conceived. At the other extreme, the self-consciously esthetic individual may often deliberately swoon over beauties sensed by him and by no one else — and in the process forget to wind his film after clicking the shutter.

Art and photography meet, of course, at many points, and among the most important of these is composition. Whatever medium you may be using, good composition results only when you exercise judgment about what shall remain in your product and what shall be excluded. If art is, in the adage, omission, then composition is in good measure the expression of that omission. Many people, however, have a vague idea that composition is a concept applicable only to art in the strict sense, and that hence it relates only remotely to photography. This idea is due to a misconception of the meaning of composition and to a foggy understanding of the relationship between art and photography. Maybe we can clarify the matter by first examining the connection between art and photography.

Six levels of photography may be distinguished. On the first level is the photo made because of the necessity for a record. You have advanced to the second level when you are so moved by a work of art as to want to copy it. This is like repeating a good story: It involves the recognition of someone else's creativeness.

The third level also involves recognition, but of something you discover, not something that has already been labeled "art." Such a picture corresponds, roughly, to telling the bright remarks you have heard a child make. A photographic example is the picture you take when you are in the country and come upon a view that impels you to open your camera and snap the scene. Or the photograph of someone whose figure or hands have inspired you to ask the person to sit for you.

You have attained the fourth level when you are not satisfied with recognizing a good theme but experiment to see how you can improve upon it. In other words you touch up, and improve upon, the "remarks" before telling them. If you are considering a landscape shot, you move around to see what is the best aspect, perhaps waiting for the sun to light up a certain area or for a figure to reach a certain spot; if you are making a portrait, in addition to moving around you watch the model in action. Some people mistake doodling with negatives at this stage for reaching the next two levels.

Milkweed ballet. This and following photographs are by the author.

The fifth level is reached when your concern with statements is no longer with their power to entertain but with the underlying qualities of the theme. Photographically, you are out to get the essence of the place, person, or thing. Being creative, work done at this stage and the next is in the realm of art.

The highest creative level is reached when you are not primarily concerned with repetition or interpretation of the ideas of others but with original compositions — giving form to new thought patterns, making new combinations of old symbols, even creating new ones. You are interested here not so much in things as they are as in what you can do with these things as symbols.

To sum up the six levels, we may say that at the bottom is *factual record;* next is the *recognition* of someone else's creativeness; then comes individual *discovery.* At the fourth level *experimentation* is added; at the fifth, *interpretation;* and at the top, *imagination* in a higher degree. It is valuable from time to time to check one's work against this scale. At each of these levels, composition is of utmost importance, but before we consider its importance we had best consider its meaning.

Composition is fundamentally the presentation of an idea — the technique of presentation being based upon a choice of almost unlimited alternatives, depending upon personal preferences. The difference between a well-composed photograph and one that is poorly composed is generally due largely to the fact that, in the bad one, the photographer did not decide at the time of taking the photograph what the idea was that he wanted to express. Consequently, as soon as you determine what you want to photograph, why you want to photograph it, and what you wish to say about the thing photographed, the job is half done. After you have determined the theme, the problem is purely one of presentation. This involves three elements: contrast, unity, and elaboration.

Contrast is the basis of composition. It is what attracts the attention. Whether you be a protozoan or a demigod, change is what you would notice more than continuation. An intermittent light, a spot of color, a silent moment, a sober man — all draw attention in proportion to their contrast with their surroundings. Photographically we are interested in contrast of mass, shape, tone, size, position, focus, action, line, and texture. Basic to all contrast is mass. In a sense, mass is the individual unit that wears the other contrasts as apparel. Place a match upon a dark table. The match is a mass; the table is a mass. Each mass has color, shape, size, and texture, all of which characteristics are in contrast with those of the other mass. In a black-and-white photograph, color is represented by black, white, or a tone of gray, while texture is represented by semblance of texture.

A mass may be more than a single object; it may be a conglomeration of objects — that is, a mass of like or unlike things that form a single visual unit. The kitten and the rubber in the photograph below form a single visual unit, as do the bridge and the skyline in the adjoining shot of the Queensborough Bridge at night. Likewise an object and its shadow generally do so if the object is appreciably darker than the background.

In the experiment with the single match and the dark table, other things being equal, the eye goes naturally to the spot where the match contrasts with the table. If now you put on the table four matches similar in all respects except that one is bent in the middle, the eye will be most drawn to the bent match, because of contrast of shape — provided you place them all near together.

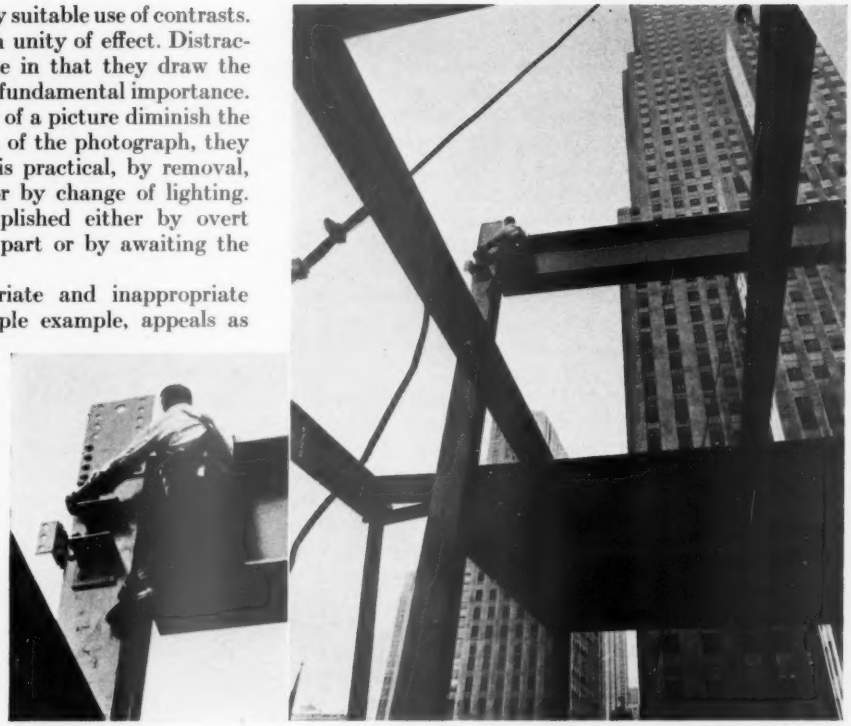
A similar experiment can be performed with black and white disks to show how contrast of tone is more potent than contrast of shape: Cut out of paper say a triangle and three disks of black and a disk of the same size of white. Then place them all on a surface of intermediate tone, arranging them equidistantly around the perimeter of a circle. You can develop similar experiments to compare the effects of contrast of size, position (at the center, near the edge, in the foreground, in the background), focus (in focus v. out of focus), action (dynamic) as against inaction (static), line (horizontal v. oblique or vertical), and texture (coarse v. smooth), as well as various combinations of these. Some effects vary with the degree of exaggeration. Thus, up to a certain point the larger object draws more attention, while beyond that point it draws less. The practical application of the foregoing observations is that when you have determined upon your theme, you set

Kitten and rubber

Bridge by night

about drawing attention to it by suitable use of contrasts. The next step is to accomplish unity of effect. Distractions resemble warts on a face in that they draw the eye to something that is not of fundamental importance. When, therefore, any elements of a picture diminish the importance of the main object of the photograph, they should be eliminated, if that is practical, by removal, by change of camera angle, or by change of lighting. These results may be accomplished either by overt action on the photographer's part or by awaiting the passage of time.

Every subject has appropriate and inappropriate moods. Water, to take a simple example, appeals as a rule to most people; but flood waters may be desolating, terrifying, or exhilarating according to circumstances. Hence the photograph must contain different tonal make-up, depending on the emotional content you intend to convey. Monotonal rendering produces a drab effect if in the middle grays; a depressing one if dark; a delicate one if light. Contrast suggests vigor, romance, hardness, crudeness, according to how the contrast is handled. There is no hard-and-fast rule of thumb for prescribing the effect ahead of time; you must develop your judgment by constant use. One very common lack of unity is found in portraits when the mouth smiles while the eyes show anxiety, or when the lighting belies the character of the sitter.



Construction scene. Upon purpose of the picture, composition depends.

Unity cannot be achieved unless the picture has a feeling of completeness, the accomplishment of which does not mean that everything except the kitchen stove has to be put into the picture, but does mean that one should feel neither lack nor surplus of subject matter and of space around it. Moreover, it is perfectly possible for more than one composition to be "the best," according to the message which is to be conveyed. The large construction picture of the Associated Press Building above, for example, was taken as a striking publicity shot to advertise Rockefeller Center at the same time. If the purpose had been to get an action shot of the workman, the composition should be reduced until it includes only that area around the man, as shown in the smaller picture.

If you wish to make your work something that will appeal to people who are interested not merely in a record photograph, you frequently must elaborate it. The only limitation to how much you may elaborate is the functional one of not distracting attention from your theme.

The most obvious form of elaboration is the use of shadow. At its best, it helps define the theme form — to make it more emphatic and to give it interesting design; at its worst, the use of shadow may be distracting. Place a cigarette on a light surface and then, with a portable lamp, throw a shadow, moving the lamp from high to low, from close to far, and turning the cigarette with respect to the light. Study the effect of the varied lighting not only on the gross design of the shadow plus cigarette but also for the effect upon the textures.

Another form of elaboration that may be used to emphasize a theme is repetition. Try the use of several cigarettes. Consider the numerical limits within which you should work. Is it possible in a picture of this sort to have so many cigarettes that they lose their meaning? Do a few cigarettes make a more emphatic picture than that provided by a single one?

Take five to ten cigarettes and arrange them on a dark surface. Look at them on the ground glass of your camera or through the view finder or, better still, through a hollow cardboard rectangle about five by seven inches, held at various distances from the eyes so as to leave much or little space around the cigarettes. Arrange the cigarettes at equal intervals in a straight line, on a diagonal, in an arc, tilting the finder laterally in order to have the pattern divide the surface into areas of differing sizes. Try also combining a rectangular form (such as a cigarette package) with a curved arrangement; a circular form (such as an ash tray) with a straight line; or lines in one direction with others thrusting at a different angle.

Pick out one of your favorite arrangements, make the spaces between the cigarettes unequal, but keep the cigarettes all of the same apparent size. Finally, by moving the finder to one side, make the cigarettes themselves appear of unequal sizes by causing them to be farther and farther from the finder. You will find it interesting to compare the result which is secured by

this means with the random configuration which is produced when you throw down the cigarettes at haphazard. From this series of experiments you will probably have discovered: (1) that items arranged geometrically have more of an appeal than do those thrown down at random; the mere orderliness gives them a rhythm, the recognition of which is pleasing to most people; (2) that cigarettes in a line parallel to the finder edge are static by comparison with those arranged obliquely, and less graceful than those arranged on a curve; (3) that equality of size and spacing is of less interest than inequality; and (4) that a movement of design in one direction can with advantage be counterbalanced by a design of similar or, better still, of different form moving in another direction.

If you now place your favorite composition on a light-colored background and add shadows to the design, you will find that every shadow will automatically take on a shape and size differing somewhat from that of its neighbor, thus giving added repetitional effects but each with a slight difference. Does the fact that the shadow of one cigarette overlaps the next cigarette confuse the theme? Does it impair the functional value of the photograph?

To summarize: Up to this point you have determined upon a theme; have added definition to your theme by the use of contrast of tone, form, and texture; and have achieved unity by the elimination of distractions. Further, you have added emphasis by repetition, or rhythm; you have relieved possible monotony by variations of pattern, size, and space; and, finally, you have seen the various effects produced by different directions of movement: horizontal, vertical, oblique, curved, and a combination and opposition of them.

These fundamental elements may be found more or less in all types of subject matter, including the portrait and the landscape. Seldom, however, do natural objects contain such a marked repetition of form as do still-life setups. This is really fortunate, because one tires easily of too much repetition. A good example of subdued rhythm in a comparatively natural object can be seen in the adjacent photograph of the bridge. Led into the picture between a series of curves no two of which are alike, the eye then follows the parallel diagonal lines of the stairway, which diagonal is repeated in the zigzag pattern of the handrail. Next the eye climbs to the horizontal masses, where the zigzag is repeated in the girders. On the right the eye is prevented from running out of the picture by the vertical tower; on the left, by the lamp standards. Note the further repetition of vertical forms in the upright girders, in the forms at the top of the stairs, and, modified, in the water stains. This picture seems a particularly fortunate one upon which to speculate. Consider how much less effective it would have been if the distant bridge piers on the right had been completely missing: The span to the right of the tower would then appear to be floating without visible means of support, an effect which would be altogether out of keeping with the solid burgherlike quality of the rest of the picture.

Consider, also, what would have happened to the picture if the tallest lamp standard had been cut down level with the top of the bridge: The weight of the picture would then be shifted to the right and the whole composition would become stodgy, owing to the lack of a prominent delicate form. Suppose, again, that the picture had been cut off immediately to the right of the tower. Two things would then happen: The eye, instead of returning over the bridge with the knowledge that further travel to the right was possible if desired, would come smack against a solid impediment, so that you would get a feeling of finality. This might please some people but would give others a very disagreeable feeling, according to their psychological needs. Likewise, the composition would become less graceful, a lack which could be partly met by cutting off some of the bottom of the picture. If, in addition, you cut the picture just to the right of the tunnel, the feeling of inability to escape would be strengthened because the eye could not get out by way of the tunnel and the tallest lamppost would take on more power to bar the way out of the picture to the left.

You can see from this detailed example how two people of unlike psychological make-ups might each prefer a different composition and each (*Concluded on page 370*)

Triborough Bridge approach

Toward a Military Calculus

Material Power and Mobility of Weapons Are Factors in an Equation Giving an Index of Tactical Strength

By John W. Meader

THE amateur headline swallower is having a hard time trying to digest the war news. He understands — or thinks he understands — the difference between "on hand" and "on order." His emotional thermometer responds to each fresh *Blitzkrieg* in inverse proportion to the square of his distance from the Atlantic seaboard. But he finds it difficult to form accurate impressions of military affairs from accounts which filter through the censorship.

In that respect the professional is not much better off than the armchair strategist, for military science is a rather loose body of thought going through rapid changes. On many principles the experts agree (this may be all a layman can ask), but their terms are seldom precisely defined or susceptible of quantitative measurement. Thus in some ways the very foundation of a science as we know it in other fields is lacking, and general understanding of military matters is on comparatively low ground. Much of the comment in the press and over the radio is objective and well informed, and the general coverage of war news has been excellent, so that the raw materials are at hand. A basis for fashioning them into studied judgments, however, is hard to find.

In a dictatorship it may be of no great importance whether the rank and file know what is being done or why it is being done; indeed, blind submission to the High Command and the Infantry Drill Regulations has its advantages. In a republic, however, war in all its phases, from preparation to demobilization, depends on voluntary support. If the people of such a state lack sound knowledge of the ways of war and are wealthy enough to be worth attacking, their independent existence is likely to be challenged. In any case, because a united front may be difficult to attain when people are free to think and to act independently, a republic may be at a disadvantage in the early stages of a war. Later, provided time permits and the people are of resolute character, a full measure of willing co-operation often results from the obvious necessity of overcoming previous neglect and early reverses. Moreover, in both factory and field, an innate capacity for independent judgment and action is an invaluable supplement to elementary strength. A citizen army properly trained and equipped, if at all comparable to the enemy numerically, has almost invariably been victorious over blood-and-iron technique. When it is more fully developed and more widely understood, military science may render its greatest service in securing support for continuous preparation for war in time of peace and in helping to bridge the critical gap between neglect and battle.

Lacking an approved military calculus, the layman has to fall back on first principles in forming his own judgments. He is galled a little at being asked to weigh labored partisan discussions of air power v. sea power while he is of the impression, mistaken or not, that the professional military man, in twenty-five years and five wars, has been unable to come up with an answer to the tank, much less an efficient handling of amphibious and three-dimensional problems.

When the destiny of Rome was being carved out by the good right arms of Caesar's legionaries, it was enough for the senate and the people to know that 30,000 well-trained troops were available against 40,000 somewhat less capable adversaries; practice, physical condition, spirit, and generalship could be counted on to make up the difference in numbers. Artillery of a sort existed in those days — "siege engines," they were called — and special troops, known as "auxiliaries," were also available. But the problem of judging the diverse effects of different arms and co-ordinating their efforts in battle was often solved, neatly and simply, by making sure that the unusual types kept out of the way of the regular sword-and-shield kind of workman. This infantry could stand up under almost any kind of onslaught.

For some time after firearms were introduced, tactics clung to established forms and rewarded with a reputation for brilliance any soldier who understood and utilized the special powers of new weapons. Napoleon's remark, "It is with artillery that war is made," at first the golden words of genius, gradually became the shibboleth of mediocrity which, in the years 1914 to 1918, could at times find no more effective use for thousands of tons of high-explosive shells than the cutting of a few hundred feet of barbed wire.

Vastly different has been the direction of the present war. Fronts have almost disappeared, and battle has acquired a fluidity and complication which only active minds can meet. By contrast with classic conceptions of the function of infantry, cavalry, and artillery — all cut to the same pattern — a long array of relatively new warlike devices must now be reckoned with. There are engines of the land, sea, and air, and for each element a diversity of size, type, quantity, organization, and use which have no common denominator. In a field so complex, first principles can be very crude and still yield valuable results. An attempt to discover such principles has sufficient excuse in the overwhelming importance of the issues at stake in current events.

The science of war is, or ought to be, the science of destruction — not wanton destruction, but destruction of the enemy's military power. All the rest is incidental

TABLE 1. MATERIAL POWER AT "MUZZLE" OF TYPICAL "GUNS"

Type of Gun	*Weight of Explosive (Pounds)**	*Approximate Number of Aimed Shots per Hour*	*Material, or Destructive, Power (Tons of Explosive Delivered per Hour at Muzzle)*
.30-inch rifle	.0049	600	.00147
.30-inch rifle (Garand)	.0049	1,200	.00294
.30-inch machine gun (light)	.0049	36,000	.0882
.50-inch machine gun	.023	13,500	.155
37-millimeter anti tank gun	.71	1,800	.639
75-millimeter field gun	5.9	900	2.66
105-millimeter howitzer	16	900	7.2
155-millimeter field gun	52	60	1.56
8-inch naval gun	118	30	1.77
12-inch naval gun, 50 caliber	397	30	5.96
14-inch naval gun, 50 caliber	631	30	9.47
16-inch naval gun, 50 caliber	942	30	14.1
Torpedo tube, 21 inches	500	4†	1
Airplane (500-pound bomb)	250‡	4§	.5

* For guns 37 millimeters and larger, estimated at 23 per cent of the cube of the diameter in inches; for smaller guns, at 18 per cent.

† Based on fifteen-minute requirement to reload tube with charged torpedo.

‡ Neglects allowance for kinetic energy of bomb.

§ Depends on size of airplane and distance from base; figured for medium bomber, with racks for two bombs, near home field, one-half hour required to land, reload, and take off.

and superfluous. The power of any modern military machine rests on explosives and fuels, and on the instruments and personnel which put them to effective use. Tacticians agree that the material power and the mobile power of an armed force are its chief characteristics. Although they sometimes speak rather loosely of the two qualities in combination as matériel, a distinction really should be made.

The beginnings of precise measurement of these qualities have appeared. The number of fieldpieces per 1,000 men, the fire power of a division, the speed of a battleship, are items frequently encountered. But none of these indexes is comparable with the other. An absolute measure of tactical strength must be found which will have the same meaning on land, on sea, and in the air. Only when tactical possibilities are understood can the combinations of generalship approach a studied perfection.

The tactical problem might be attacked by at least three methods: the historical, the statistical, and the engineering. All of these methods have already yielded some result, with definite advances in military science stemming from them. For instance, naval literature has nothing finer than Mahan's *The Influence of Sea Power Upon History, 1660–1783*. First published more than fifty years ago, it still dominates naval thought although it is rather dry reading for anyone born without salt water in his blood. Statistical methods, indispensable in many military calculations, would have even more valuable application to tactical problems if adequate data were available. Published records of actual campaigns, unfortunately, are fragmentary at best. Many documents relating to the first awful weeks in France in August, 1914, were not released at all and may now have disappeared forever. During hostilities, military information is naturally designed to conceal more than it reveals. Engineering methods have produced notable successes in the development of weapons and in their manufacture, but scientific studies of tactical and strategic problems through research and experiment have lagged.

Although each of these methods will have an important place in the development of the science, it is proposed here to suggest only how engineering calculations might be extended to cover tactical problems in a rational way. The assumptions are few and almost self-evident, approximate data are readily available, and the mathematical operations make no greater demands on the intellect than does the mental arithmetic of a shopkeeper.

The first assumption is that material power can be measured by the rate at which explosives may be delivered on a military target. A convenient unit of measurement might be one ton of nitrocellulose or its equivalent per hour. That is a fairly large unit, recognized as equal to about five horsepower when expressed in terms of foot-pounds per second.

Whether the explosive is fired in the gun barrel or in the shell makes little difference; wherever the explosive is discharged, it will have, presumably, an equivalent effect. In any gun the destructive work is done by the explosive — the projectile serving mainly as a sort of catalytic agent for converting the force of the explosion into disruption of the target. A torpedo tube may also be considered as a gun — the torpedo being the projectile — but in a torpedo tube the propellant is chiefly compressed air obtained by burning some fuel in a separate air-compressing engine. An airplane is also a kind of projectile, launched from a landing field by means of high-test gas and carrying, in bombs or other ammunition, a charge of explosive analogous to that in a shell fired from a gun.

Table 1 gives rough calculations of the material, or destructive, powers of certain "guns" at their "muzzles." The figures are based on newspaper descriptions and other easily available sources, supplemented by a little guesswork, and are intended to be merely illustrative and suggestive.

When weapons of different basic character are compared, strict parallels must be maintained. The airplane, taken alone, might be considered either as a gun which fires a projectile (bomb), or as a compound projectile "fired" from a "gun" in the form of an air base. To stretch the point one step farther, an air base and its appurtenant airplanes and bombs might be considered as a complex projectile launched from the industrial system of a country. Similarly, a submarine might be regarded as a compound projectile issuing from a naval-base "gun."

The clearest analogy for present purposes seems to occur when the airplane bomb and the torpedo are considered as projectiles comparable to artillery shells. The material power, being the product of the weight of explosive per shot and the number of aimed shots per hour, is easily ascertained for guns. For air bombs and torpedoes,

the weight of the explosives is a definite quantity, but the number of "shots" per hour has had to be estimated with a large margin of possible error. The question is: How fast can a stream of bombs (torpedoes) be fired from an airplane (torpedo tube)? If the airplane has racks for only two bombs, it must land, reload the racks, and take off for every two "shots." A torpedo tube may be reloaded much more quickly with a charged spare, to the extent, of course, that such spares are carried. We are not here concerned with limitations arising from the supply of ammunition or with the cost or efficiency of exerting destructive power.

Mobile power is not so easily defined. Obviously, it is the facility with which destructive power may be exerted at a distance. But how is that quality to be measured? Mobility, or ease of transportation, or whatever it is, is meaningless as a thing apart. Mobility is at work in a Sunday drive into the country, but no military destruction occurs. Material power, as defined above, is equally abstract, for unless it is exerted at a distance it destroys itself rather than the enemy. Material and mobility must go hand in hand; one without the other is useless in a military sense. Immobile material power is only one short step from annihilation.

The military contractor, called upon to deliver his load of destructive power at Timbuktu, has to work under a heavy time penalty. If he takes forever to do the job, the whole thing might as well be forgotten, for the war will be over by that time. In a tactical sense, mobile power is the ability to deliver at a distance in a given time. That is simply velocity, in any language.

Tactical power, which combines material and mobile power, is the ability to get there first with the most men, long recognized as an aphorism of war. Tactical power is the *product*, not the sum, of material power and mobile power. If mobile power is miles per hour, and material power is nitrocellulose tons per hour, the product of the two is nitrocellulose ton-miles per hour per hour. The fact that such an expression is like a second derivative with respect to time need not take us very far into differential calculus; it simply emphasizes the time intensity of military action.

Table 2 shows what might be called the relative "middle-distance" tactical powers of representative weapons, reached in the way just described — by multiplying material power by speed of movement of the weapon. The ratings are of relative value only, since there are large variations of tactical power in the field. For instance, being in the dark, or beyond the range of possible movement, or without gun crew or ammunition, renders tactical power temporarily zero. Also, the figures are continuous ratings of what is essentially an intermittent process. A loaded gun trained on a target has much greater momentary power than does one which has just been discharged, but when a number of guns are involved, the continuous rating has practical application.

Some military authorities take the rather narrower view that tactics cease and strategy begins when guns are out of firing range; others speak of grand tactics in that connection. The implicit purpose of any movement forward, however, is to close the range. Such movement can begin far outside the extreme range of the piece and continue until the range is reduced virtually to zero.

TABLE 2. RELATIVE "MIDDLE-DISTANCE" TACTICAL POWERS OF TYPICAL WEAPONS

Type of Weapon	*Material Power (See Table 1)*	*Mobile Power (Approximate Speed of Weapon in Miles per Hour)*	*Relative Tactical Power (See Text)*
Rifleman on foot	.00147	2	.0029
Machine gun, .30 inch (light)	.0882	40*	3.6
Medium tank (one .30-inch light machine gun, one .50-inch machine gun, one 75-millimeter gun)	2.90	40*	116
Antitank gun, 37 millimeters	.639	40*	26
Howitzer, 105 millimeters	7.20	40*	288
Battleship (nine 16-inch guns, 50 caliber)†	127	31.1	3,900
Submarine (four tubes)	4	6	24
Fighter airplane (eight guns)	.0141‡	350	4.9
Bombing airplane, medium	.50	300	150

* Maximum speed of motorized equipment over suitable ground.

† U.S.S. *North Carolina*, main battery only.

‡ Fighter planes carry special guns firing at double the rate of light machine guns, but continuous gunfire is limited to eighteen seconds during each of two flights per hour, near base.

With the exception of the naval vessel and the fighter airplane, it is important that during the time a piece is being moved, it is incapable of firing with any appreciable accuracy. The table therefore tends to underrate the tactical powers of the ship and the plane as well as the importance of speed in actual warfare, especially at close quarters.

Furthermore, the calculations are based on material power at the "muzzle," which is a theoretical limit never quite realized, but which may be nonetheless a useful criterion of relative tactical power. Not all gunfire results in hits. During World War I a ton of assorted hardware was required to kill a man. For the purposes of actual battle we should need to reckon tactical power on the basis of the velocity of the *projectile* rather than the gun and to apply a statistical correction for inaccuracy in the shooting.

Almost all projectiles fired from guns have the same muzzle velocity (about 1,900 miles per hour) and are much superior to airplanes (about 575 mph when dived from a considerable height), and to torpedoes (which are very slow, making only 42 mph at medium ranges). The latter are therefore poor bullets to use against fast-moving targets. Guns have, characteristically, much the same variations in accuracy, which decreases, for instance, with the square of the target distance.

The chances of making a full hit on any imaginary point are almost absurdly small. Fortunately for the peace of mind of artillery colonels, guns are not required to hit imaginary targets on the nose. Some gunners boast of their ability to drive rivets at 40,000 yards, but such claims can be written off as 99.44 per cent sheer nonsense. The typical scatter pattern is to be compared with targets of measurable, sometimes very great, size.

(*Continued on page 378*)

Aiding Aging

As the Nation Slowly Approaches Maturation and Man Lives Long Enough to Have Time to Think, Geriatrics — the Treatment of Disease in the Aged — Attains Importance

By Edward J. Stieglitz

THE age of the universe has puzzled astronomers, the age of the earth has long interested geologists, and the age of man as a species has been the concern of anthropologists and archaeologists for many years. But the aging of *man as an individual* has received scant attention, and very little, indeed, is known anent the basic mechanisms of aging as a biological process. A young world is interested in youth. Mankind, however, is slowly progressing toward maturation, and as culture advances we are commencing to realize the importance of the elderly.

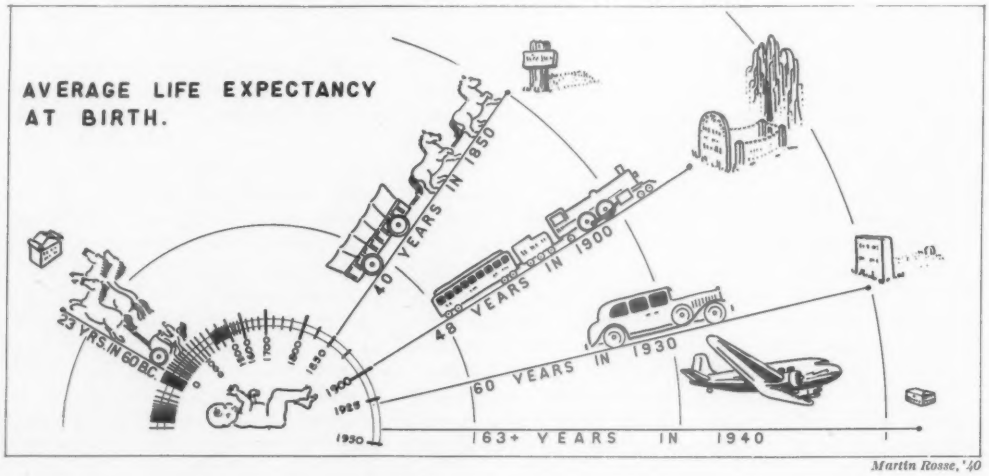
Though the ancient Greeks delighted in the philosophic discussions of their aged seers, in those days the old were objects of curiosity because of their rarity. In Rome, Cicero wrote his famed *De Senectute* several years before his death at sixty-three. He considered himself an old man in the fifties, and justly so, for few of his contemporaries survived to such ripeness. The average life expectancy at birth for the Roman citizen was about twenty-three years, according to cautious estimates. During the next nineteen centuries the average was raised but very slowly. In 1850 data from New England indicate that life expectancy at birth was only forty years. By 1900 the average had risen to forty-eight years for the United States as a whole, and since then the rise has been dramatic. In 1930 life expectancy at birth had increased to about sixty years of age, and it is now over sixty-three for our white population.

Looking at the changing picture of humanity from another angle, we see that in 1900 only 17 per cent of the total population of the United States were forty-five years old or more. In 1940, 26.5 per cent were over forty-five, and conservative projection results in the estimate that in 1980 — only forty years hence — more than 40 per cent of our population will be over forty-five years of age.

Figures from the 1940 census reveal that the median age of the population of this country increased from 26.4 years in 1930 to 28.9 years in 1940. This is an increase of two and a half years of median age within a decade. The median age of the population will probably be forty-four years in another half century. Furthermore, the number of persons aged sixty-five or more has increased from 6,633,805 to 8,956,206. This is a rise of 35 per cent among the elderly, as contrasted with a 7.2 per cent increase in the total population in the last decade.

Such figures speak for themselves. Because of them, gerontology, the science of aging, is no longer merely academically interesting but has become an urgent matter in the minds of those who can see the handwriting on the wall. The nation is aging rapidly. The virile, violent, but short-lived days of physical pioneering are largely past. The future holds promise of profound change. A period of intellectual conquest may be dawning. Man at last lives long enough to have time to think.

Geriatrics, the special field of medical practice dealing with disease in aged individuals, consequently becomes urgently important. The two terms, gerontology and geriatrics, must not be confused; the aged whom geriatrics seeks to protect are the consequences of aging which gerontology seeks to understand. The aged are



Why geriatrics is becoming urgently important appears as we visualize the increasing expectancy of life.

Martin Rosse, '40

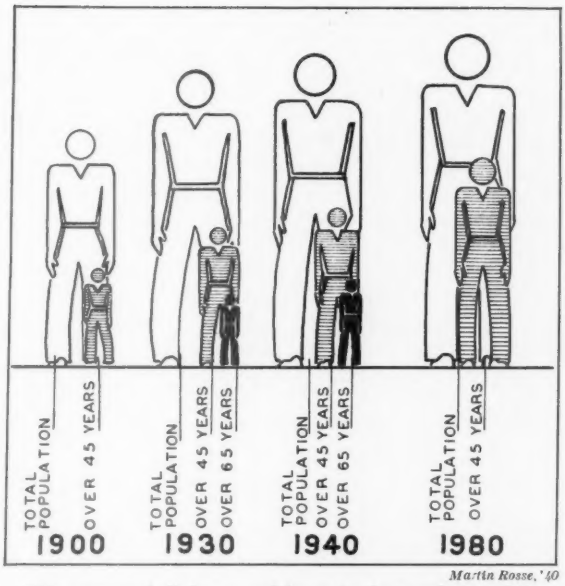
people; aging is a process which starts with the conception of a new individual and continues throughout life. A part of living, it thus involves both evolutional and involutional phenomena. Senescence may be defined as that part of the aging process which occurs after the peak of development. Though the changes of senescence are largely involutional, they do not represent solely decline. There are important compensations in certain functional capacities. Though long neglected, the unutilized potentialities of the aging are worthy of serious consideration.

Just as geriatrics is concerned with the treatment of disease, preventive geriatrics is interested in the prevention of disease in later life. Probably the most significant period from the point of view of prophylactic geriatrics is the two decades from forty to sixty. It is in this period, or even before, that the involutional processes start, later to reveal themselves in the more obvious evidences of aging. Preventive geriatrics does not set as its objective the prevention of aging, for to do that would be to arrest life. We cannot stop growing older, but we can hope to modify the consequences of aging and retard the progression of certain factors which make for premature senescence.

The present situation is wholly without precedent. Never before in the history of mankind has a like problem presented itself; there are no marked trails to follow. It is our responsibility to explore as far as we are able, however, for great longevity without health not only is an individual tragedy but may develop into a social evil viciously destructive to national economy. Increased longevity of the population *can* become an incalculably valuable asset to the commonwealth, if the potentialities of the elderly are wisely guided.

Urgent and unanswered problems arise in economic, sociologic, political, and psychiatric fields as well as in medicine. The direction of some of these problems is already indicated. The clamor of the aged for economic security is heard throughout the breadth of the land. This clamor will become louder. Fantastic schemes are advocated with fanatic vigor and have already taken on political flavor. The problem of employment of older men demands serious and immediate attention, for logic inexorably leads to the conclusion that either the increasing millions of elderly people must have opportunity to work and support themselves or the proportionately dwindling group of younger persons will have to support them in one way or another.

Education, which is preparation, has not kept pace with these changes in the social order. Educational curricula are still geared to the day when life expectancy was fifteen or twenty years less than that of today; when education to prepare the boy or girl for the competition of adult life sufficed. Neither parents nor teachers have taken cognizance of the necessity for preparation for old age. They have assumed with complacent smugness that the adult would learn how to grow old gracefully, happily, and usefully without training or aid. Unfortunately, very few learn this art spontaneously. The time has come when educators must revise their objectives. The accomplishments of such men as Oliver Wendell Holmes, William H. Welch, Thomas A. Edison, Goethe, Titian, and many others in the evening of their lives are mere indicators of the vast storehouse of latent treasure in those so often sneeringly dubbed "old men." The remarkable increase in life expectancy may be attributed largely to control of infectious diseases in childhood and early adult life. This control has been accomplished chiefly by the public health officer and the pediatrician. Through the institution and maintenance of modern sanitation, infant mortality has been dramatically reduced. Summer complaint among infants was a dreaded disorder only the older ones of us remember. It passed with the disappearance of contaminated milk and water. Typhoid fever not so many years ago filled the wards of the hospitals in our major cities. Today sufficient cases for the teaching of medical students are hard to find. Cholera, plague, smallpox, diphtheria, and scarlet fever are under control through quarantine and immunization.



Martin Rosse, '40

Older persons bulk larger and larger in the population of the United States.

Prophylactic pediatrics has contributed greatly to increasing life expectancy. Not only has a vast improvement been made in the curative therapy of childhood disease, but more has been done by the pediatricians than by any other group of physicians to advocate and apply individual preventive medicine. Worthy of emphasis is the fact that marked advances in pediatric knowledge followed recognition of the fundamental concept that the child is not merely "the little man" but presents nutritional, immunological, functional, and structural problems and characteristics *peculiar to* infancy and childhood. A similar focus of attention in connection with the senescent individual presents problems quite different because of specific, though ill understood and less appreciated, structural and functional differences. Thus geriatrics, or the care of the aged, becomes dependent upon gerontology, the science of aging.

The problems of aging, with which gerontology is concerned, are logically divisible into the three major categories which follow: (*Continued on page 382*)

Riding Fence

Patrolling Zones Vital to Hemisphere Defense Is But One of the Jobs for the Navy's Flying Fleets

By S. Paul Johnston

IN the days of John Paul Jones, the Navy's* job was comparatively simple. Our coastal lines were short. Sea lanes important to us were not extensive. A string of wooden frigates scattered along the eastern seaboard sufficed to guarantee our shores and to maintain for our commerce the freedom of the seas.

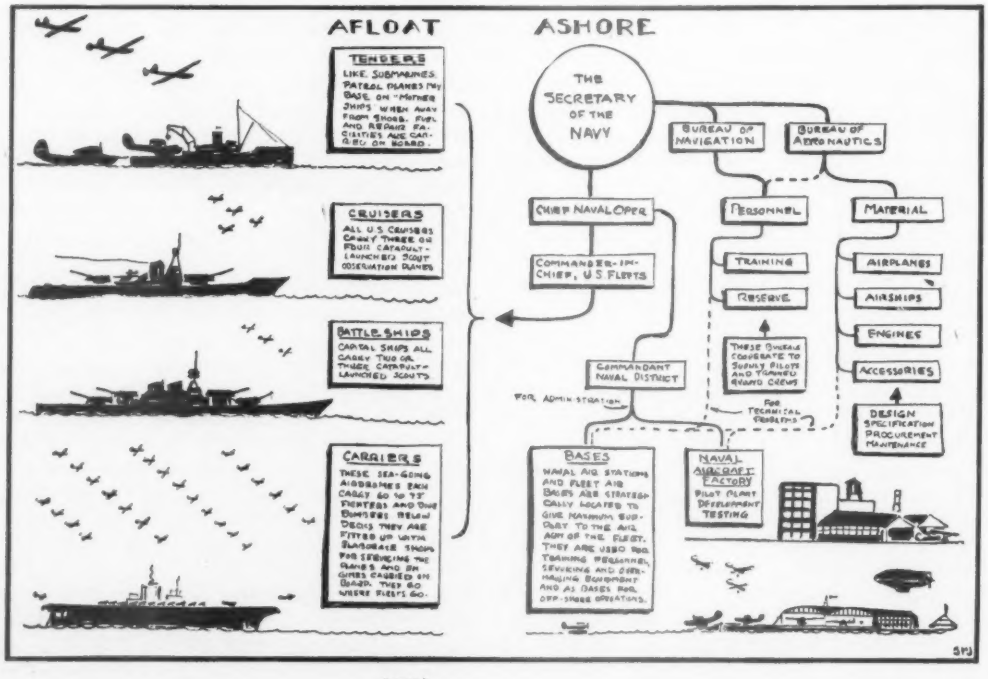
For a hundred years our naval problem changed only in degree. Coast lines were lengthened considerably, and the scope of our seagoing commerce became world wide. Sail gave way to steam, wood to steel, but the strategic and tactical problems that faced Admiral Dewey in 1898 were essentially the same as those of Captain Paul in 1778. We simply built enough of the right kind of battleship and cruiser to keep up with requirements.

An event took place in mid-December of 1903, however, that changed all that simplicity, created new problems. Man learned to fly. Very soon he had learned to fly so well and so far that fortresses ashore and fleets at sea were no longer barriers to the coming and going of an enemy. In less than forty years after the invention of the airplane, fleets of heavy bombers and swift fighters were in existence and could range for thousands of miles, some with tons of bombs on board. Theaters of war were no longer restricted to predetermined areas at sea and on land. Nations discovered the futility of Maginot lines. The theory that the nation which ruled the seas ruled the world became suspect. England found that the channel was no longer a fence, and that the Royal Navy was no great protection against an invader from the skies.

We too are learning our lesson. Fortunately, we are learning it by example and not from bitter experience. We know now that we cannot expect to defend ourselves by erecting fences along our seacoasts. If an enemy comes even within sight of our shores, we are already too late; our first lines of defense have been broken — we have been invaded. By that time hostile aircraft launched from carriers at sea or from bases on the American continents could be pounding at the hearts of our industrial areas. Our real frontiers lie many miles offshore. To see that they stay there is the Navy's job.

The airplane has not only forced extension of our lines of defense; the airplane has also made easier our maintenance of these lines. Vast stretches of ocean can be patrolled from bases strategically located on the fringes of our vital areas. Enemy movements can be scouted out

* All opinions expressed in this article are those of the author and in no way reflect the attitude of any government service or agency.


AFLOAT
ASHORE
TENDERS
LIKE SUBMARINES. PATROL PLANES MAY BASE ON "MOTHER SHIPS" WHEN AWAY FROM SHORE. FUEL AND REPAIR FACILITIES ARE CARRIED ON BOARD.
CRUISERS
ALL U.S. CRUISERS CARRY THREE OR FOUR CATAPULT-LAUNCHED SCOUT OBSERVATION PLANES
BATTLESHIPS
CAPITAL SHIPS ALL CARRY TWO OR THREE CATAPULT-LAUNCHED SCOUTS
CARRIERS
THESE SEA-GOING AIRDROMES EACH CARRY 60 TO 75 FIGHTERS AND DIVE BOMBERS. BELOW DECKS THEY ARE FITTED UP WITH ELABORATE SHOPS FOR SERVICING THE PLANES AND BOMBS CARRIED ON BOARD. THEY GO WHERE FLEETS GO.
THE SECRETARY OF THE NAVY
BUREAU OF NAVIGATION
BUREAU OF AERONAUTICS
CHIEF NAVAL OPER
PERSONNEL
MATERIAL
COMMANDER-IN-CHIEF, U.S. FLEETS
TRAINING
RESERVE
AIRPLANES
AIRSHIPS
ENGINES
ACCESSORIES
THESE BUREAUS COOPERATE TO SUPPLY PILOTS AND TECHNICAL GROUND CREWS
COMMANDANT NAVAL DISTRICT
FOR ADMINISTRATION
FOR TECHNICAL PROBLEMS
DESIGN SPECIFICATION PROCUREMENT MAINTENANCE
BASES
NAVAL AIR STATIONS AND FLEET AIR BASES ARE STRATEGICALLY LOCATED TO GIVE MAXIMUM SUPPORT TO THE AIR ARM OF THE FLEET. THEY ARE USED FOR TRAINING PERSONNEL, SERVICING AND EQUIPPING EQUIPMENT AND AS BASES FOR OFF-SHORE OPERATIONS.
NAVAL AIRCRAFT FACTORY
PILOT PLANT DEVELOPMENT TESTING
SPJ

How America's flying fleets are organized afloat and ashore

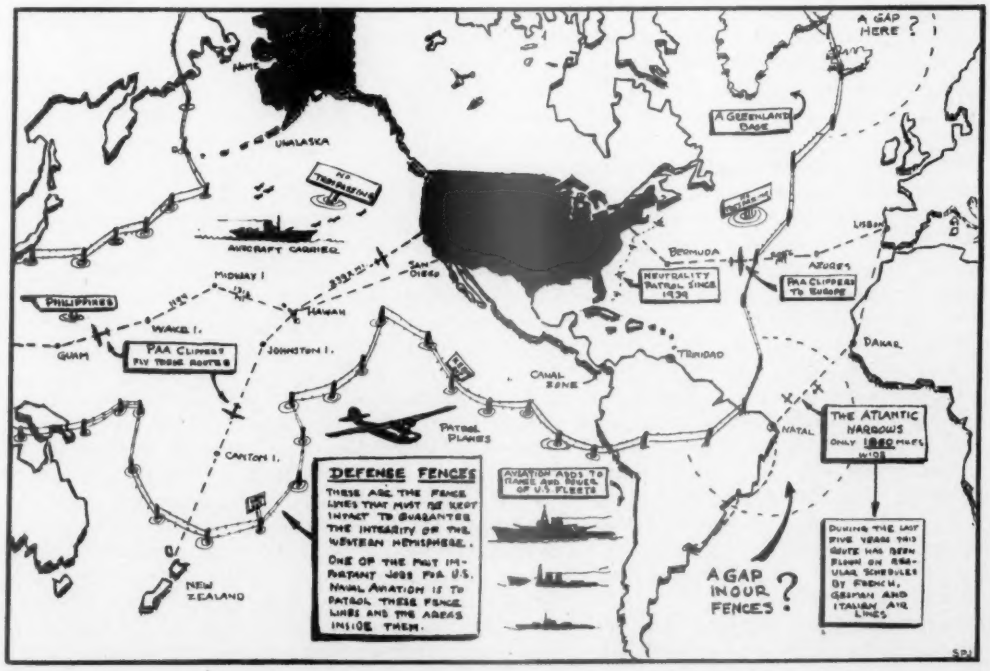
long before they develop, and enemy fleets attempting to penetrate our defense lines can be greeted by concentrations of bombers. Aviation has become a necessary and an integral part of our Navy. Fleets that fly have changed the entire defensive strategy of the United States.

Battle fleets afloat or aloft cannot be self-sustaining for indefinite periods. Battleships and cruisers may stay at sea for weeks or months, but sooner or later they must put in at shore bases for fuel, for ammunition, and for supplies. Aircraft require attention at much shorter intervals — a matter of hours or of a few days at most. Hence bases at points such as Unalaska, Hawaii, Guam, British Guiana, Bermuda, and Newfoundland are important. Until recently many of these points were not available for our use. There were gaps in our fence lines, particularly in the Caribbean area. Our recent agreements with Great Britain, however, have opened up to us the bases that we need to permit long-range naval aircraft to keep our fences in order.

Much loose talk has been going on about the range of operation of modern aircraft. It is true that large bombers and huge flying boats are being designed and built to operate nonstop, with military loads, for six or seven thousand miles; but for a long time to come these craft will be the exception rather than the rule in anybody's air force. Effective radii of action for air attack and defense are much shorter than those six or seven thousand miles; they average around fifteen hundred miles. Our naval patrol squadrons are now supplied with large numbers of aircraft that can easily fly nonstop well over three or four thousand miles. Their effective radius of action is, however, somewhat less than half their extreme range. If patrol aircraft are to perform useful missions, they must be able to do a considerable amount of cruising far out at sea and must also have enough reserve fuel so that there will not be any question about getting back to base. When we take such factors into account, an arbitrary limit of 1,500 miles seems reasonable for a practical operating range for modern flying fleets. The accompanying map has been drawn on this basis. It shows the fence lines some fifteen hundred miles offshore which must be patrolled by our naval aviation.

Weakest link in the chain lies to the south and east of the Caribbean, beyond the area that can be covered from Trinidad or British Guiana, where South America and Africa are less than 2,000 miles apart. For several years a number of European countries have been flying mail and freight on regular schedule between Dakar in French West Africa and Natal in Brazil. Hundreds of flights have been made across the South Atlantic in all kinds of weather. In that area plenty of experience has been accumulated which might easily be turned to military account. In order to protect ourselves at that point, and primarily to prevent any European power's securing a foothold in the northeastern tip of South America, the establishment of another base farther east seems necessary, either at Pará or at Natal itself. From such a point our shore-based aircraft could sweep the entire Atlantic Narrows without difficulty.

The map explains why the Navy has gone in for big, seaworthy, long-range flying boats. Our current and projected designs are the most efficient in the world. Planes like the two-engined Consolidated PBY's and the Martin PBM's will shortly be supplemented by larger four-engined Vought-Sikorsky, Martin, and Consolidated airplanes — battleships of the air, easily capable of patrolling fences thousands of miles offshore in any weather, carrying guns enough for their own protection, and packing in their bomb bays missiles large enough to sink battleships. A few such planes are now in service; hundreds more on order. (*Continued on page 390*)


A GAP HERE ?
A GREENLAND BASE
UNALASKA
AIRCRAFT CARRIER
BERMUDA
AZORES
LISBON
NEUTRALITY PATROL SINCE 1939
PAA CLIPPERS TO EUROPE
PHILIPPINES
MIDWAY I.
HAWAII
SAN DIEGO
WAKE I.
GUAM
PAA CLIPPERS FLY THESE ROUTES
JOHNSTON I.
TRINIDAD
DAKAR
CANAL ZONE
PATROL PLANES
NATAL
THE ATLANTIC NARROWS ONLY 1800 MILES WIDE
CANTON I.
DEFENSE FENCES
THESE ARE THE FENCE LINES THAT MUST BE KEPT INTACT TO GUARANTEE THE INTEGRITY OF THE WESTERN HEMISPHERE.
ONE OF THE MOST IMPORTANT JOBS FOR U.S. NAVAL AVIATION IS TO PATROL THESE FENCE LINES AND THE AREAS INSIDE THEM.
AVIATION ADDS TO RANGE AND POWER OF U.S. FLEETS
DURING THE LAST FIVE YEARS THIS ROUTE HAS BEEN FLOWN ON REGULAR SCHEDULES BY FRENCH, GERMAN AND ITALIAN AIR LINES
NEW ZEALAND
A GAP IN OUR FENCES ?

Naval aviation's patrolling job as it appears on the map

Industrial Mathematics

In Many Ways the Mathematician Can Be of Direct Service to Industry; Qualified Men Are Needed

By T. C. Fry

An unfortunate phenomenon that must be dealt with in aircraft design is a type of violent vibration which may be set up in the wings of a plane if it is flown too fast. This "flutter," as the vibration is called, is highly dangerous since it may cause loss of control or structural failure. The designer's problem is to be sure that the speed at which flutter would occur is higher than any speed at which the craft would ever be flown. Experimental investigation in wind tunnels is difficult, and flight testing is very dangerous. But in this situation, as in many others, mathematics fills the breach in the research and development work of industry when experiments are virtually impossible: Mathematical studies not only predict the critical speeds and frequencies of flutter for aircraft still in the design stage but also point to modifications of design which will insure against the occurrence of flutter in the usable speed range.

Mathematics also can sometimes make unnecessary large amounts of experimental testing, thus enabling time and money to be saved, as in the extrapolation of test data from one set of dimensions to a widely different set. The characteristics of full-size airplanes are determined from the characteristics found in wind tunnel measurements on small-scale models. The petroleum industry uses mathematics to determine the best of several possible ways of producing oil from a given field. The oil-gas mixture below the ground flows under pressure through porous mediums, and the industry's problem is to determine the most economical way to recover the mixture.

By explaining why experimental observations don't fit a preconceived theory, mathematics sometimes aids in perfecting a theory for further use. The classic illustration is, of course, the planet Neptune, discovery of which resulted from the inconsistency of the motion of Uranus with the motion called for by the Newtonian theory of gravitation. Another illustration may be cited from the aircraft industry: The behavior of airplanes with "power on" did not check closely enough with the stability predictions which had been made without consideration of the effects of the application of power. A purely mathematical analysis of the longitudinal motion of an airplane was carried out, involving the solution of three simultaneous linear first-degree differential equations. The results led to the development of equations for dynamic longitudinal stability with power on, which permitted more accurate predictions of the stability characteristics of given designs.

Communication engineering also offers an illustration: Theoretical studies had established the fact that vacuum tubes would spontaneously generate noise because of the discrete character of the electrons of which space current is composed. The theory predicted how loud the noise would be in any particular type of vacuum tube, a most significant result since it established a limit to the weakness of signals which could be amplified by such a tube. The predictions of the theory were supported by experimental data as long as the tubes were operating without appreciable space charge. But when space charge was present, the noise level fell far below the predicted minimum. Although the missing factor in the theory was immediately obvious, an understanding of the mechanism by which the reduction was effected and the incorporation of the knowledge into the theory in a workable form required an extensive and difficult mathematical attack.

Mathematical techniques provide a basis and method for interpreting experimental data in terms of a preconceived theory of physics so as to draw deductions regarding things which cannot be observed conveniently, if at all. Among many possible industrial examples are methods of locating faults on long-distance telephone lines; and the determination of the depth and tilt of underground layers and thus of the most favorable position for an oil well.

Mathematics is also frequently used in devising so-called crucial experiments to enable a decision to be made between rival theories. It indicated the astronomical observations which would decide between the older theory of mechanics and the most modern of relativity, and predicted the confirmation of the latter. Sometimes mathematics serves in a negative way to forestall experimental search for the impossible. In industry many desirable objectives are as unattainable as perpetual-motion machines; frequently the only way to recognize the fact is by means of a mathematical argument. Several illustrations are offered in the arts of electrical communication where, despite the rapidly accumulating list of accomplishments, there are still things which it is absurd to try to do.

For industry, mathematics also plays its part by reducing complicated theoretical results and intricate methods of calculation to convenient working forms. Illustrations can be cited from the technical problems involved in the design of rotating machinery, in which the parts must be dynamically balanced; from the design of aircraft, in which the usual structural theories cannot be applied directly to the calculation of the metal skin and of the re-enforcing stiffeners; and from the complicated circuits of wire telephony and radiotelephony. Mathematicians have built machines which

perform complex mathematical operations to deliver to designers conclusions in easily understandable form. The machines are mechanical methods for saving mathematical labor; but they are more than that, for they all rest upon a foundation of mathematical theory. They are, in fact, examples of the use of mathematics to avoid the use of mathematics.

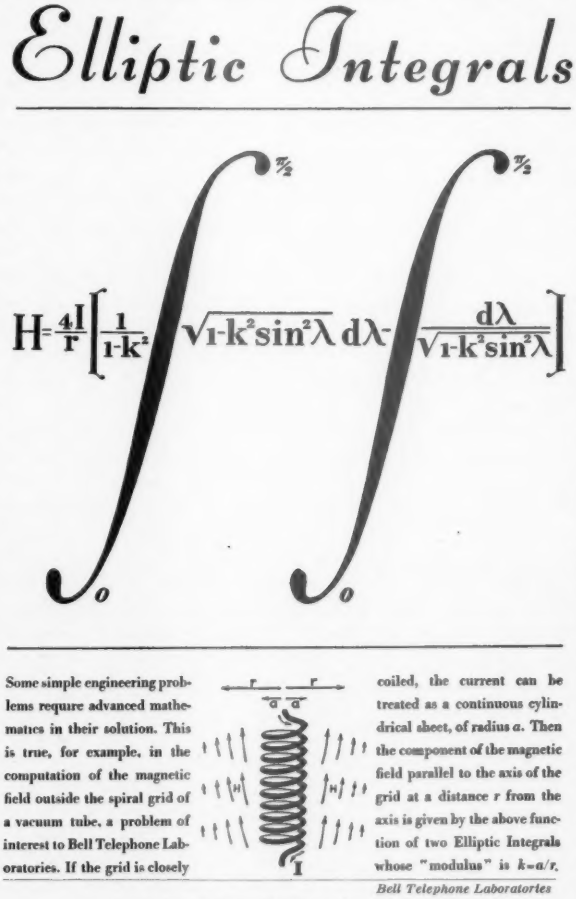
In addition to such applications of mathematics to the problems of technical industries, there is another whole field in the application of the mathematical theories of statistics. Statisticians, from the standpoint of mathematics, are those who are using or developing such mathematical theories. Not included is the much larger number of persons who collect, chart, and scrutinize factual data concerning the economic problems of insurance and finance, economic forecasting, and market surveys.

The mathematical statistician can assist industry by showing how to study experimental data in order to determine whether observed variations are accidental or significant. For example, in the geochemical method of prospecting for oil, samples of surface soil are taken and analyzed for their proportions of hydrocarbons and waxes. The normal samples, of course, vary considerably among themselves, in part because analysis is always more or less approximate, and in larger part because of errors in sampling. Nevertheless, statistical methods can disclose which areas of those surveyed are favorable for petroleum, which are unfavorable, marginal, or indeterminate.

Because the statistician can tell what variations among samples are significant, he can and should be called as a consultant when experiments are being planned to obtain sampling data. For example, surgical sutures — twisted strands of sheep intestine slit lengthwise — cannot be tested without being destroyed. After a surgical operation, such sutures are digested by the human body and disappear as healing proceeds. The final test of a manufactured lot must be made by sampling and testing some of the lot. The appraisal of the quality of the remainder of the lot rests, then, upon probability; its laws and their interpretation are the peculiar function of the statistician. For similar reasons the statistician can be of value in a manufacturing company at each stage of the process. He can assist in laying out the routine for the inspection of a manufactured product. He can tell how to use the day-to-day results of inspection to detect any incipient degradation which might otherwise have escaped notice in the manufacturing process. And because he can do these things, he can assist the manufacturer or the purchaser in writing "rational" specifications which will insure that the purchased raw material or the finished product shall have the desired qualities.

Although mathematical techniques of one or another of the types which have been mentioned are used in practically all of the research and developmental activities of technical industry, the men who use the techniques would not normally be called "mathematicians." Few have come from the mathematical departments of universities. In fact, most of the mathematicians in industry were originally trained as physicists or as electrical or mechanical engineers, gravitating into their present work because of a strong interest and an inherent ability in mathematics. Engineers, physicists, and chemists are, of course, thoroughly trained in many of the mathematical methods here discussed. In their technical college courses, such students are constantly being trained in higher and higher mathematics. "Higher mathematics" means simply those branches of the science which have not yet found wide application. Industry has relied largely upon the lower branches, but as industry finds uses for more of the higher mathematics, the colleges tend to add courses in those higher branches for the training of engineers and scientists. As scientists, then, these men are university trained; as practicing mathematicians they are self-educated. Their training has not been ideal, but at present America has no school where the proper training can be acquired.

Today America leads the world in pure mathematics and perhaps also in that branch of mathematics known as modern physics. We have strong centers of actuarial and statistical training. In the field of applied mathematics, however, we stand no farther forward than we did at the end of the last century and far behind most European countries. A quarter of a century ago suitable teachers would have been difficult to find. But today a number of European scholars (*Continued on page 393*)



Some simple engineering problems require advanced mathematics in their solution. This is true, for example, in the computation of the magnetic field outside the spiral grid of a vacuum tube, a problem of interest to Bell Telephone Laboratories. If the grid is closely coiled, the current can be treated as a continuous cylindrical sheet, of radius a. Then the component of the magnetic field parallel to the axis of the grid at a distance r from the axis is given by the above function of two Elliptic Integrals whose "modulus" is $k=a/r$.

Bell Telephone Laboratories

An industrial application of mathematics

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Alumni Day 1941

Stimulating Program of Varied Interest Is Planned for Returning Alumni

ALTHOUGH Alumni Day was established only seven years ago, it already has the unmistakable flavor of a custom rich in the ingredients that build traditions. This year, faced by the uncertainties and dangers of a world emergency, Alumni Day offers Technology men an opportunity for expressing that unity of professional purpose and clearness of vision which form the basis of all technological progress.

At no hour in its history has the country been more dependent upon its scientists and engineers for the very substance of national security. No small part of the direction of force essential for orderly progress comes from the maintenance of a balanced pattern of life which provides for a change of pace, the interchange of ideas, and the satisfactions of renewing old friendships. Hence the value of taking time out in these tense days to return to Technology for Alumni Day.

The symposia, which have been the most important events of Alumni Day programs from the very first, have without exception focused attention on subjects of great current importance and wide interest. The significance of last year's conference on "Channels of World News and Opinion" has been fully revealed in the passing months of world crises. This year, when the health of the nation is a matter of paramount concern for national defense and all the resources of modern medical science are being mobilized for the preservation of life, a discussion, by leaders in their fields, on "Science and Engineering as Allies of Medicine" suggests a conference of extraordinary current significance.

Plans for Alumni Day, which are announced in detail on pages 334 and 335, reveal a program in which appropriate events will include a tribute to the memory of Richard C. Maclaurin, President of Technology from 1909 to 1920, and a review of the Institute's progress in the twenty-five years since M.I.T. crossed the Charles to the buildings in Cambridge. Under President Maclaurin's leadership the new Technology, enriched by the magnificent gift from George Eastman, was built. Dr. Maclaurin's contributions to its advancement will be given permanent recognition in the dedication of a memorial inscription in the lobby of the main building.

The distinguished speakers at this year's conference will be Dr. Frank H. Lahey, Director of The Lahey Clinic in Boston and President-elect of the American Medical Association; George R. Harrison, Professor of Physics and Director of the Institute's Research Laboratory of Experimental Physics; and Detlev W. Bronk of the medical college of Cornell University, who is internationally recognized as an authority on medical physics. Presiding will be Samuel C. Prescott, '94, the Institute's Dean of Science and Head of the Department of Biology and Public Health.

Supplementing the conference will be a comprehensive exhibition presenting working models of apparatus developed by scientists and engineers for the diagnosis and cure of disease and for medical research. Covering a broad range, the exhibits will include electrical apparatus used in recording and analyzing brain waves; electrocardiography, which is employed for studying heart action; ultraviolet-light equipment relating to bactericidal and vitamin-producing effects; radio-active indicators, a promising tool of medical research; and apparatus for measuring vitamin content and studying specimens of highly concentrated foods. Also displayed will be exhibits of spectrographic equipment used in medical research, high-voltage x-ray generators, cyclotrons and high-voltage machines, and polarized light.

In the afternoon, following the pleasant luncheon in Du Pont Court, Alumni will participate in the Class Day exercises of this year's Senior Class. Members of the fifty- and twenty-five-year classes of 1891 and 1916 will contribute to the program. The special ceremonies at which the memorial to President Maclaurin will be dedicated are to be held at four o'clock and will be followed by the unveiling of a portrait of President Compton in the Rogers Building.

The annual "Stein-on-the-Table" dinner will be held at the Hotel Statler, where, in the principal address of the program, Dr. Compton will report on current activities of the Institute.

The energetic and resourceful committee in charge of the entertainment of ladies has provided a program of interesting variety. From nine to ten on the morning of Alumni Day, coffee will be served in the Emma Rogers Room, and the ladies, of course, are invited to the symposium, which begins at 10:00 A.M. Then will come the luncheon in Du Pont Court and the Class Day exercises followed by ceremonies to dedicate the memorial to President Maclaurin and the unveiling of the portrait of Dr. Compton in the lobby of the Rogers Building. From four to five-thirty o'clock Mrs. Compton will hold open house at her home on Charles River Road, from which the ladies will proceed to a dinner at the Brae Burn Country Club. Later they will join Alumni at the Hotel Statler for the program following the banquet. There will also be opportunities for sight-seeing trips in Cambridge and Boston and motorboat trips on the Charles River Basin.

Richard Whiting, '26, is chairman of the Alumni Day committee responsible for the work that has gone into preparing this rounded program. The executive com-

Class Reunions Summarized

Regular five-year reunions are to be held this spring by classes of –1 and –6 years, as follows:

1891 — New Ocean House, Swampscott, Mass. June 6 to 8

1896 — East Bay Lodge, Osterville, Mass. June 5 to 8

1901 — New Ocean House, Swampscott, Mass. June 7 and 8

1906 — Eastern Yacht Club, Marblehead, Mass. June 6 to 8

1911 — Mayflower Hotel (Manomet Point), Plymouth, Mass. June 6 to 9. Ladies included

1916 — Oyster Harbors Club, Osterville, Mass. June 7 and 8

1921 — The Griswold, Eastern Point, New London, Conn. June 6 to 8. — Yachts may come directly to the Griswold. — Airplane landing field two miles distant

1926 — Boxwood Manor, Old Lyme, Conn. Arrive morning of June 7 and depart afternoon of June 8

1931 — Riversea Inn, Old Saybrook, Conn. June 7 and 8

1936 — Cliff Hotel, Scituate, Mass. June 7 and 8

Other classes holding meetings during the June festivities are these:

1888 — Thirteenth Webster Class Dinner, 307 Hammond Street, Chestnut Hill, Mass. June 8, 5:30 P.M.

1904 — Boxwood Manor, Old Lyme, Conn. June 27 to 29

1914 — Plan to hold just a predinner meeting at the Hotel Statler on the afternoon of Alumni Day

1915 — Predinner meeting at the Hotel Statler, Monday, June 9, from four to seven

1922 — Headquarters at Hotel Kenmore, June 8 and 9. Come for informal Sunday get-together

mittee under his direction includes: Charles E. Locke, '96, Raymond H. Blanchard, '17, John D. Mitsch, '20, Edward R. Schwarz, '23, Kenneth C. Reynolds, '25, James R. Killian, Jr., '26, Ralph T. Jope, '28, John G. Trump, '33, Donald P. Severance, '38, Horace S. Ford, and Mrs. Leicester F. Hamilton.

Subcommittees are as follows: *Class Day:* John D. Mitsch, '20, *chairman*, Henry A. Fiske, '91, James A. Burbank, '16, and Eugene Mirabelli, '19. *Dinner:* Raymond H. Blanchard, '17, *chairman*, Arthur L. Shaw, '09, Warren E. Glancy, '13, Josiah D. Crosby, '21, Delbert W. Kendall, '24, and Herbert R. Stewart, '24. *Exhibits:* John G. Trump, '33, *chairman*, J. Warren Horton, '14, Robert S. Harris, '28, Albert M. Grass, '34, Francis J. Safford, '34, Robert W. Cloud, '37, Dr. Richard Dresser, Robley D. Evans, Isidor Fankuchen, George R. Harrison, George G. Harvey, Dr. James R. Lingley, M. Stanley Livingston, John R. Loofbourow, Arthur Roberts, Robert J. Van de Graaff and Arthur C. Watson. *Ladies' events:* Mrs. Leicester F. Hamilton, *chairman*, Mrs. Howard R. Bartlett, Mrs. Arthur A. Blanchard, Mrs. Raymond H. Blanchard, Mrs. Karl T. Compton, Mrs. Horace S. Ford, Mrs. Carle R. Hayward, Mrs. Ralph T. Jope, Mrs. Henry B. Shepard, Mrs. Stephen G. Simpson, Mrs. Richard Whiting, and Mrs. Henry E. Worcester. *Luncheon:* Kenneth C. Reynolds, '25, *chairman*, James Holt, '19, Bernard E. Proctor, '23, Herbert L. Beckwith, '26, and Howard R. Staley, '35. *Publicity and promotion:* Ralph T. Jope, '28, *chairman*, Henry B. Kane, '24, James Donovan, '28, John J. Rowlands, and Frederick G. Fassett, Jr. *Registration:* Donald P. Severance, '38, *chairman*, Joseph C. MacKinnon, '13,

Louis Rosenblum '42

At the quarter-century mark the Great Dome of the Institute, as infrared depicts it, awaits the throngs of Alumni Day.

Robert M. Kimball, '33, and Wolcott A. Hokanson. *Symposium:* Edward R. Schwarz, '23, *chairman. Ways and means:* Horace S. Ford, *chairman*, Albert V. Smith, '20, and Delbert L. Rhind. *Twenty-five years in Cambridge:* James R. Killian, Jr., '26, *chairman*, Alf K. Berle, '27. *Alumni Day stein:* designed by Henry B. Kane, '24.

Commencement Broadcast

THE commencement address of Robert E. Wilson, '16, at the Institute's seventy-fourth graduation exercises in Symphony Hall, Boston, in addition to being broadcast by Station WMEX, will be shortwaved to the world through Station WRUL of the World Wide Broadcasting Foundation from 11:00 A.M. to 12:00 noon, eastern daylight-saving time, on June 10.

For listeners in the United States and Canada, the WRUL broadcast will be heard best on the 11.79 megacycle band. Europe and Australia will hear the address on the 17.75 megacycle wave band. The broadcast will include the opening of the graduation ceremonies and the introduction of Dr. Wilson by President Compton.

New Laboratory

CONSTRUCTION of a large laboratory which will be occupied by the Department of Chemical Engineering has been started at the Institute, and the building is expected to be ready for use in November. In announcing plans for the new structure, President Compton said that expansion of facilities for Chemical Engineering, now the largest Department in the Institute, has long been an urgent need. The Executive Committee of the Institute authorized construction of the new laboratory at this time because of increasing opportunities for the Institute to use its facilities for research and for training programs related to national defense.

"The full potentialities of the Chemical Engineering Department for technical training and research," said Dr. Compton, "have been retarded by a lack of more adequate laboratories and more convenient grouping of its various activities. This condition has been pointed out year after year by the Departmental Visiting Committees of men distinguished in the chemical and oil industries who have studied the operations and needs of the Department. It was the recognition of this long-felt want in the regular educational program of the Institute, combined with the fact that such facilities, if available, could be immediately used for the national welfare during this emergency which induced the Executive Committee of the Institute to authorize construction of the laboratory at once."

The new laboratory will be located behind and adjacent to the main educational building, east of the central dome. The building, covering a plot 200 feet long and 125 feet wide, will be a two-story structure, permitting the introduction of large areas of skylight for effective natural lighting. It will have an exterior finish of buff face-brick to harmonize with the surrounding buildings.

The new chemical engineering building will have a floor area of more than 50,000 square feet and is to be connected to the main buildings by a covered passageway. The central portion of the basement floor will be devoted to two laboratories two stories in height to permit ample room for large-scale apparatus to be used in chemical engineering instruction and research and in fuel studies. On the same floor will be three industrial chemistry laboratories, storerooms, shops, and service areas. Around the outside of the first floor are to be thirty offices and thesis rooms as well as four class and conference rooms. In addition, two large industrial chemistry laboratories will be located on this floor, the central section of which is to be occupied by the upper section of the unit operations and fuel laboratories.

Plans for the building were prepared by the architectural firm of Coolidge and Carlson [Harry J. Carlson, '92], and the contract for the foundation has been awarded to McCreery and Theriault [George W. McCreery, '19]. The building will cost $500,000.

Walter G. Whitman, '17, is head of the Department of Chemical Engineering, which now has an enrollment of more than four hundred graduate and undergraduate students. The Institute, it will be recalled, pioneered in introducing chemical engineering education by establishing the first course in 1888, and its graduates in chemical engineering, which is concerned with the development and application of manufacturing processes in which chemical as well as physical changes of materials are involved, have played a notable part in the development of American industry. The Department operates the School of Chemical Engineering Practice, established under a special gift from

"Headwall," by A. William Welch, '41, XIII, was adjudged "best in show" at the recent second annual salon of the M.I.T. Camera Club. More than a third again as many entries were attracted this year. Mr. Welch is from Grand Rapids, Mich., and has been a member of the club since its inception.

George Eastman. In this School, which is the engineering equivalent of a hospital providing internship for students in medicine, graduate engineers in chemical engineering apply their training in various phases of industrial practice in large plants in New York, New Jersey, and Maine. The special teaching methods developed in chemical engineering at the Institute have been generally accepted as the bases for professional instruction in other schools. Readiness to try new methods has been a hallmark of the Department's attack on both teaching and research.

Robert E. Rogers, 1888–1941

GENERALLY regarded," in *Fortune's* phrase, "as the most powerful leaven in the Institute's loaf," Robert E. Rogers, Professor of English and, for more than a quarter-century, guide, philosopher, and friend to Technology men, died on May 13. He had been actively teaching in the traditional Rogers way until the opening of the spring term of this year, when impaired health necessitated his taking leave of absence. His death takes from undergraduate Technology one of its most forceful and best-loved teachers and from alumni Technology a figure remembered by hundreds on hundreds of graduates for wit, for sound teaching, for insistence upon the imponderable values of life.

Chairman and speaker at innumerable student meetings and as many alumni gatherings, Professor Rogers carried his work for and interest in Technology men far beyond the classroom and the lecture hall. The All-Tech smoker at which the freshman began to understand what the Institute intends, and the senior dinner at which the soon-to-be Alumnus looked back and knew at last what the Institute meant and means — at these meetings particularly Bob Rogers struck blows in the right direction. A sensitive and appreciative student of language and literature, he brought to such occasions, as to his class teaching and his notable group lectures to freshmen and sophomores, the vigor of an alert and well-stored mind, with the urbanity and the comradeliness of a nature well meriting the distinction of Dr. Johnson's highest compliment — he was eminently a clubbable man.

Of the many ways in which Professor Rogers placed his varied abilities at the service of the Institute, few meant more to Alumni than his assumption, for the years from 1917 to 1922, of the editorship of The Review. The first non-Alumnus to hold the post, he took the responsibility when Isaac W. Litchfield, '85, was called to government service as America entered the World War. Under Professor Rogers' blue pencil the pages of the magazine had a vitality and a sparkle that marked his incumbency as one of the high points in its history, and they bore as well many paragraphs evidencing both his deep understanding of the purposes of the Institute and his high conception of its being. From all the wealth of this writing, however, The Review now elects not to draw; rather, it remembers its editor of the war years in these concluding lines of the moving poem from his pen in the issue for January, 1920, in memory of the Institute's great President Richard Cockburn Maclaurin:

Gerlach

Robert E. Rogers

Tomorrow morning
The young men will go busily across the place where he lay shrouded in violets
Young men with eager voices upon their business.
But there will be a great sunshine on the snow,
A great sunshine through the long windows,
And on the pavement a few sprays of bloom,
Dropped and scattered violets,
And in the high places . . . a spirit . . .
That will not die.

For lo, the winter is past
And the day-spring cometh!

Born at Haddonfield, N. J., on April 12, 1888, the son of Charles Merrill and Mary Ellen (Pickup) Rogers, Robert E. Rogers prepared for college at Cambridge Latin School. He was graduated from Harvard in 1909 with the degrees of bachelor and master of arts. During the next year he was instructor in English at Williams College, after which he was in the theatrical business with the Maude Adams Company for a year. In 1911 and 1912 he was a member of the editorial staff of the Brooklyn *Eagle*. Coming to the Department of English in the Institute as instructor in 1913, he was promoted to assistant professor in 1917, to associate professor in 1923, and to professor in 1934. For some twenty years he had been a lecturer in the Massachusetts University Extension courses. Editor of The Review between 1917 and 1922, he held a similar post on *Creative Reading* between 1927 and 1931. From 1930 to 1938, he wrote a daily column for the Boston evening *American*.

His writings included a play, *Behind a Watteau Picture*, 1918; an anthology, *The Voice of Science in 19th Century Literature*, 1920; *The Fine Art of Reading*, 1929; and *How to Be Interesting*, 1931. He was a member of Phi Beta Kappa. In 1918 Professor Rogers was married to Marie Baer; they have a daughter, Marie Desiree Baer.

Huntington Portrait

A PORTRAIT of Ralph Huntington, for whom Huntington Hall in the old Rogers Building in Boston was named, has been presented to the Institute by his grandniece, Mrs. John L. Batchelder, and now hangs at the entrance of the Institute's largest lecture hall, to which his name was transferred when the old Rogers Building was demolished.

Ralph Huntington was one of the Institute's early benefactors, and the generous bequest of $80,000 which came to Technology upon his death in 1866 was prompted by his active interest in advancing the influence of the Institute while he was a member of its Corporation from 1862 until his death. A successful merchant and banker, Ralph Huntington also had the vision of an engineer, and it was he who advocated filling in the Back Bay tidal basin. Thus, a project which was once ridiculed as "Huntington's Folly" created a new section of Boston of enormous value to the city. Huntington Avenue, named for Mr. Huntington, was laid out in 1864 and became one of the important thoroughfares across the newly created land of Back Bay.

The significance of old Huntington Hall extended far beyond its use as a place of assembly for the early students of the Institute. As the scene of innumerable public gatherings, it became one of the country's great intellectual centers where statesmen and famous clergymen, scientists, great writers, and leading thinkers of the day came to speak. Here it was that for so many years the distinguished Lowell Institute Lectures were given, and it was in Huntington Hall that the great Phillips Brooks preached when fire destroyed his church.

The Huntington portrait, though unsigned, suggests the fine work of Chester Harding, celebrated portrait painter of his day. Comparison with other portraits by Harding reveals a striking similarity in technique.

Mrs. Batchelder's interest in the Institute is not limited to the association of her distinguished granduncle with Technology, for her husband is a prominent member of the Class of 1890, and he shared her pleasure in presenting the Huntington portrait to Technology.

Active Alumnae

A CURRENT exhibition of the work of members of the M.I.T. Women's Association, displayed in the Emma Rogers Room at the Institute, presents convincing evidence of important accomplishments over a wide range of professional fields.

The exhibits include specimens of textiles woven by Myra L. Davis, '03, of Boston; a research project on the preservation of color in flowers by drying them in borax, the work of Frances Ropes Williams, '04, Winchester, Mass.; a group of professional papers by Mildred Allen, '22, associate professor of physics at Mount Holyoke; Frances H. Clark, '22, metallurgist in the laboratories of the Western Union Telegraph Company, New York; Margaret E. Maltby, '91, former head of the department of physics at Barnard College; Dorothy W. Weeks, '23, professor and head of the department of physics at Wilson College; and Edith Clarke, '19, of the laboratories of the General Electric Company in Schenectady, N. Y.

Shaw Photo Service

The Ralph Huntington Portrait

Patents for an oxygen-absorbing solution are exhibited by Dorothy Quiggle, '26, associate professor of chemical engineering at Pennsylvania State College, and the notable work of Alice Ballard Crosby, '79, is given recognition in a certificate of appreciation for her services to the New England Hospital for Women and Children, Boston. Philomena R. Caputo, '23, of the department of public welfare, Boston, exhibits statistical material, while Dr. Alice G. Bryant, '86, physician attached to the Deaconess Hospital, Boston, has a most interesting exhibit of special surgical instruments she has developed in her long medical career. Architects who are represented by photographs of their works are Lois L. Howe, '90, Eleanor Manning O'Connor, '06, and Marjorie Pierce, '22, who is president of the M.I.T. Women's Association. Architectural models are exhibited by Helen Baxter Perrin, '24. She and her husband, Hugh Perrin, '24, form the architectural model firm of Perrin and Perrin. Ruth Andrews Dean, '29, has an interesting exhibit of pottery, and numerous other exhibits include books by alumnae in the fields of health, genealogy, and philosophy.

Elected

OFFICERS of the Alumni Association elected for the year to come were announced at the 220th meeting of the Alumni Council on the last Monday in April. B. Edwin Hutchinson, '09, will head the Association as president; Harold Bugbee, '20, will serve as vice-president for two years; C. Yardley Chittick, '22, and Herbert S. Cleverdon, '10, as members of the Executive Committee for two years; E. Pennell Brooks, '17, George J. Mead, '16, and Robert E. Wilson, '16, as term members of the Corporation for five years. Charles A. Smith, '99, was announced as (*Continued on page 396*)

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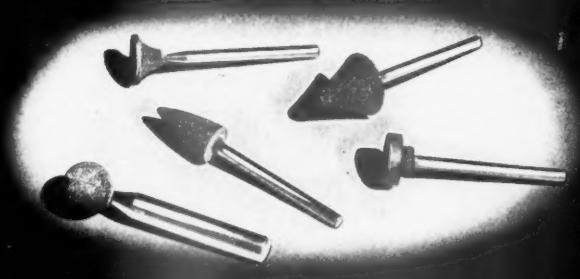

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COMPOSITION IN PHOTOGRAPHY

(*Concluded from page 354*)

be right. There is good reason to believe that a person who is mentally or physically shortsighted, and who therefore habitually sees things a little blurred, tends to accept a photo that is fuzzy both intellectually and physically; and that the unimaginative person tends to overstress technical perfection at the expense of content.

Composition has frequently been made to seem complicated by the substitution of rote and dogma for basic principles. Dusty tomes and concise summaries have been written about such aspects as balance; placing; lead ins; ways out; triangular, circular, and square arrangements; tonal distribution; and so forth. Those who learn composition this way are in danger of using the information more as a crutch than as a tool, relying upon the judgment of others rather than upon their own. To use the subject as a tool, you have only to grasp the thought that *functionalism* is the guide and touchstone of good composition, not only in the sense of working within the limitations of your materials but also in the obverse sense that everything in a picture must function to bring out the theme. Singleness of theme is, of course, fundamentally important. That and simplification, elaboration, contrast, texture, shadow, rhythm, balance, design, tonal distribution, placing, cropping, and so on, are all limited by the functional criterion. Within this limitation, personal preference has free play to express itself; and, in view of the fact that this preference is based upon the individual's psychological needs, as many different solutions should be possible as there are individuals.

PRESENT PLEASURES OR FUTURE BENEFITS?

(*Concluded from page 348*)

manner. The President assured labor that it would not have to give up any of the advantages which it had secured. The doctrine that we could prepare but would not have to make a sacrifice was generally preached. It has now become clear that this doctrine also will not work and that sacrifices will have to be made if we are going to meet our problems effectively.

If this program means much to us, we must go into it with the attitude that no sacrifice is too great to accomplish it. Whenever a strike breaks out in some great industry, whether the fault is that of management or labor, we have a situation in which the selfish interests of a group have placed themselves above the national interests at a critical time. To the extent that we permit groups to do so, we are falling short of what would be expected of an intelligent and high-minded citizenship. To that extent we are demonstrating that we have not risen nearly so far as we sometimes think in what I have called our "standard of civilization."

We must be willing to tackle the job which we have to tackle at this particular time, and we must let nothing stand in the way of our carrying it through successfully. We can easily envisage the material things which are needed, such as ships, airplanes, a trained personnel in Army and Navy, and all the equipment and supplies which are necessary to make these efficiently operative. But more than anything else, I believe, we need the unity of purpose, the courage, and the indomitable will to see the job through to a finish. Then after the job is finished, we need a great deal of wisdom, consideration, and courage to see that this nation and the other nations do not make the same mistakes of omission and commission which followed the World War, or make other mistakes which may be equally bad.

We have learned within our communities and within our nation to live as a social group of individuals, each retaining a very large portion of liberty and initiative and surrendering this liberty only when it interferes with the rights of others. We have been able to keep this desirable social status because we have been willing to make the sacrifices necessary to maintain a police power which will deal drastically with those who overstep the bounds prescribed by our laws. We have been able to some extent to introduce into our business and political life the same principles of honesty and good sportsmanship which have grown up in the relations among individuals.

In the long process of the evolution of society, the next step is certainly to introduce these same elements into the relationships among nations, because the same fundamental qualities of honesty and fair play can handle international situations just as they can handle individual or regional problems. The League of Nations, which was a notable effort in this direction, failed because some of the nations refused to participate, some which did participate were not actuated by motives of fair play, and practically no members of the group were willing to undertake the responsibility and the risk of any sort of police power to enforce the principles and regulations which had been adopted.

Certainly if Great Britain is successful in this war with whatever help we in America are willing and able to give her, there will be another opportunity to establish an international program designed to prevent the re-occurrence of a destructive world struggle. Some people say that this will be our last chance. "Last" is a very conclusive word. I do not know whether it will be our last chance, but of one thing we may be sure: If we get the chance, it will be the best chance which is likely to come for a long time to us or our children to bring about a permanent solution of the problems of war. In the hope that we may secure the chance and handle the opportunity wisely when it comes, we have, I believe, our greatest incentive to rise to great heights in the spirit of national service in this emergency.

OIL AND THE AXIS

(*Continued from page 350*)

her control. The matter of getting this oil into Germany, however, is by no means so simple as might appear. Before the war about 75 per cent of Rumania's exports were shipped out by sea. Tank cars and Danube barges carried only about 27,000 barrels a day, about two-thirds of which went into Austria, Hungary, and eastern Germany. Rumania contracted to supply Germany with some 30,000 barrels a day in 1940, but up to July sent only about 20,000 a day. (*Continued on page 372*)

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OIL AND THE AXIS

(*Continued from page 370*)

Shipments shrank thus probably because of the longer average haul (it is about 1,800 miles to western Germany), because of the unusually severe winter, and because of transportation difficulties including a mysterious shortage of barges. That shortage in all likelihood had much to do with the penetration of Rumania last summer and its seizure last fall. Even seizure did not solve all transportation problems, and the best evidence indicates that total exports to Germany and Italy averaged slightly under 30,000 barrels a day for the year 1940. I believe this lack of outlet, rather than the earthquake, to be the principal reason for the curtailment of Rumanian output during the last quarter of last year. The difficulties of moving adequate oil supplies to Germany's mechanized forces in western Europe may well have been a factor in Hitler's decision to transfer a substantial part of these forces to Rumania, where they can operate with oil supplies close behind them — a sort of version of Mohammed and the mountain.

On the whole, if the Axis is able to import an average total of 50,000 barrels a day from Rumania into Germany and Italy during 1941, it will have done an excellent job. From England's point of view, attacks on communications from Rumania, rather than on Rumanian oil wells and refineries, would probably be the most productive of prompt and valuable results.

(4) *Imports from Russia.* Russian oil supplies to Germany have been widely advertised, but either Russia's inability to spare any oil or the difficult transportation problems involved have kept German imports to an almost negligible figure. The direct rail haul from the Baku region to western Germany is about 2,500 miles, and the difference in railroad gauge necessitates a transfer en route. Russia as well as Germany, moreover, has been short of tank cars. The more efficient route by pipe line to Batum on the Black Sea, tanker to Constanta, and barge or tank car through Rumania serves merely to congest the shorter route from Rumania's own fields.

Germany probably has got the lion's share of the oil produced in the Russian-occupied part of Poland (amounting to about 8,000 barrels a day) and some heavy lubricating oils. Germany is particularly in need of these, and neither her synthetic plants nor Rumania can supply them. Admittedly based more on the logic of the situation than on any actual figures, my guess would be that Germany's average imports from Russia since the war began have been about 15,000 barrels a day. Even this amount would be some five times Germany's pre-war imports from Russia.

(5) *Supplies from the Near East.* Numerous columnists and armchair strategists have in recent months expressed the opinion that Germany's Balkan adventures were stimulated largely by her desire to supplement her supplies from the oil fields of the Near East. From what I have shown of transporta- (*Continued on page 374*)

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OIL AND THE AXIS

(*Continued from page 372*)

tion bottlenecks in getting oil from the much nearer fields of Rumania and Russia, the unlikelihood of such a theory must be apparent. Even if the Near East fields could be captured in usable condition, as seems highly improbable, they would be of no value for getting oil into Germany unless she had effective control of the Mediterranean.

To summarize the German situation, it appears that during 1940 total Axis production of petroleum and its products, not including Italian imports before Italy entered the war or stocks seized during the *Blitzkrieg*, probably averaged about 150,000 barrels a day. This is about 35 per cent of the peacetime requirements of Axis-occupied territory (not including Rumania). In other words, German supplies have been cut to about one-third at a time when total needs have probably doubled in order to meet the military, industrial, agricultural, and civil demands. Of course, the supply and demand problem has been answered by the practical elimination of all civilian consumption throughout the occupied territory and very sharp curtailment of industrial and agricultural consumption.

The answer to the common question, "Is Germany short of oil?" must be, "Yes," as far as the broad picture is concerned. Even in Germany such sharp curtailment of civilian consumption must mean much loss of efficiency. The fine new roads which Hitler built to relieve his railroads in the event of war are contributing little to German wartime economy, for everything possible must be hauled by rail to save gasoline. On the other hand, it does appear that both the army and the *Gestapo* have adequate supplies of gasoline for all their operations and for day-to-day use. I do not believe that any purely military operation has thus far suffered from a lack of over-all gasoline supplies. As a matter of fact, less than 100,000 barrels a day of petroleum products properly distributed should keep even the German army going its present pace more or less indefinitely.

The greatest uncertainty about the whole German situation lies in the stocks with which Germany started the war and what has happened to them since. I cannot give credence to reports that she had tucked away two years' normal supply — some 100,000,000 barrels. If she had had any such stocks, she would not have run short, as she did, of the vital lubricating oil before the war was a year old. She may well have accumulated some 30,000,000 or possibly 40,000,000 barrels of stocks, reckoning that these would see her through a two-year period, during which she assumed she could win the war, build enough more synthetic plants to carry her, or seize Rumania. But she could hardly have foreseen the necessity of having to supply at least some oil to almost all of Europe for a long period, without having won the war. This analysis seems to leave one very pertinent question unanswered. If Germany has plenty of gasoline for her army, why has she never made more effective use of her 20,000 to 25,000 first-line planes in continued all-out attacks on England? Why do "breathing spaces" of weeks generally precede and (*Concluded on page 376*)

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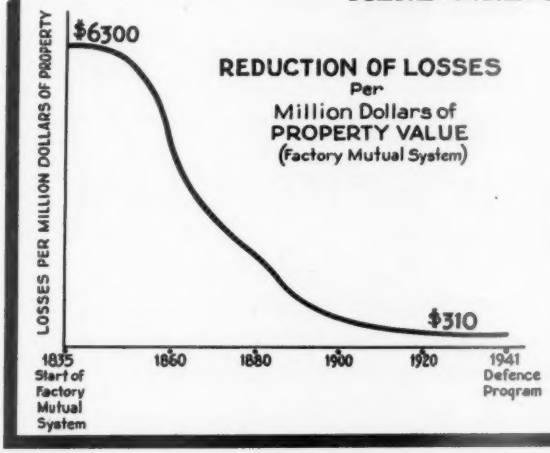

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OIL AND THE AXIS

(*Concluded from page 374*)

follow such heavy attacks as she has made, even with only 2,000 planes? Fuel shortage might be a logical answer, but it does not appear that there can be any serious shortage of aviation gasoline in Germany as a whole. The supply and transportation problems involved in such attacks afford a more logical explanation.

Let us assume that Germany should decide to use 8,000 bombers and 4,000 pursuit planes — half her total force — in an attack on England, and let us further assume that she had some 200 suitable airports available along the invasion coast of western France around to Norway. To prepare for such an attack, provision would have to be made for storing, maintaining, fueling, and taking on and off about sixty planes at each airport, despite probable attacks by opposing bombers. To put such a fleet of 12,000 planes into the air for only five hours a day would require about 7,000,000 gallons of gasoline and about 18,000 tons of bombs daily.

With the limited transportation facilities available, bringing up enough such material, plus mechanics, spare parts, and so on, for a week's attack would undoubtedly require several weeks, and the material once brought up would thereafter be subject to loss by bombing. It is not strange that Germany was not able to assemble enough such supplies to make an effective all-out attack on England last fall. Even with a long winter of preparation, including building and camouflage of new air fields and hangars, building underground storage facilities, and so on, it would be an almost superhuman task to bring a force of 12,000 airplanes to bear against England for even a few hours, to say nothing of continuing such an attack for the several days which would probably be the necessary preparation for invasion. Germany is reported to have several "flying tankers" designed to supply fuel to remote airports, but the cost of gasoline delivered in this way, when she is already short of gasoline, must be almost prohibitive.

Whether Germany's oil shortage will seriously hamper her this summer seems difficult to predict, but there are three ways in which the oil situation is working against her for the long pull. They are:

(1) Italy, only partly because of lack of oil, will be more a liability than an asset to Hitler from now on.

(2) Germany's long-pull oil outlook must be discouraging to her and must require considerable diversion of attention and energy which she would prefer to use in other ways. The shortage must also interfere increasingly with both her industrial and agricultural production and eventually with her military operations.

(3) If and when England can achieve sufficient air superiority to permit long-range and heavy daylight attacks on German synthetic plants and transportation facilities, she will be striking at such a vital spot that actual invasion might never be necessary for England to win the war.

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TOWARD A MILITARY CALCULUS

(*Continued from page 357*)

Although a large gun, because of the greater sectional area of the projectile and the longer barrel, is inherently more accurate than a small gun, the latter has an advantage in greater rapidity of fire, which affords more chances to make a hit from a given quantity of discharged explosive. When any hit will suffice — but only then — the smaller the bullet the better.

Torpedoes, at similar ranges, may have a somewhat higher accuracy than have shells, because the depth at which torpedoes run is controlled by the medium through which they pass, the control being continuous from tube to target. The scatter pattern is in a horizontal line rather than a circle leaning at an angle.

With regard to airplanes, dive bombing is far more accurate (and dangerous) than high-level bombing. At any distance beyond a few miles from base, an airplane, if driven right into collision with the target, would be incomparably more accurate than a shell fired from a gun. The "trajectory" would be controlled (by the pilot) during flight right up to the moment of contact. But an airplane would still lose tactical power rapidly with distance from base, as the additional fuel required would reduce the bomb load. Somewhat similarly, torpedoes lose tactical power with distance from the tube, as the speed of the run must be reduced for long-range firing. All weapons are alike, then, in offering an increase in power at a shorter range and in paying high dividends on mobility.

In actual practice, of course, airplanes do not drive into their targets but release their bombs at a comparatively long distance from them. Even dive bombers leave a "margin of safety" of some 500 feet. The accuracy of airplane bombing is always far below theoretical perfection, whereas gun and torpedo fire, at close ranges, may very closely approach the theoretical maximum.

When it is judged on the basis of what little evidence is at present available to the public, airplane bombing is about as accurate as three-inch gunfire at the same range and is hence more accurate than the fire of smaller guns and less accurate than that of larger guns. The effective range of field guns against other guns and infantry is ordinarily thought to be not more than two miles. The accuracy of air bombing from heights to which airplanes may be driven by anti-aircraft gunfire (some 20,000 feet) is thus of the order of one-fourth that of a small fieldpiece; but from a height of 500 feet the accuracy would be much greater than that of a three-inch gun firing from a distance of two miles. The defensive importance of anti-aircraft guns is to be judged not altogether by the bag of airplanes they bring down but by the height at which they compel airplanes to fly for safety's sake.

Even with all the foregoing qualifications in mind and the degree of speculation necessarily involved, Table 2 yields, or supports, some interesting observations. A tank theoretically is worth at least a regiment of riflemen on foot. In fact, the foot soldier, the infantry of the classic school, appears as (*Continued on page 380*)

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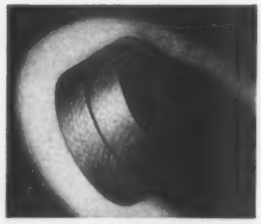

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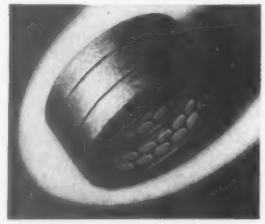

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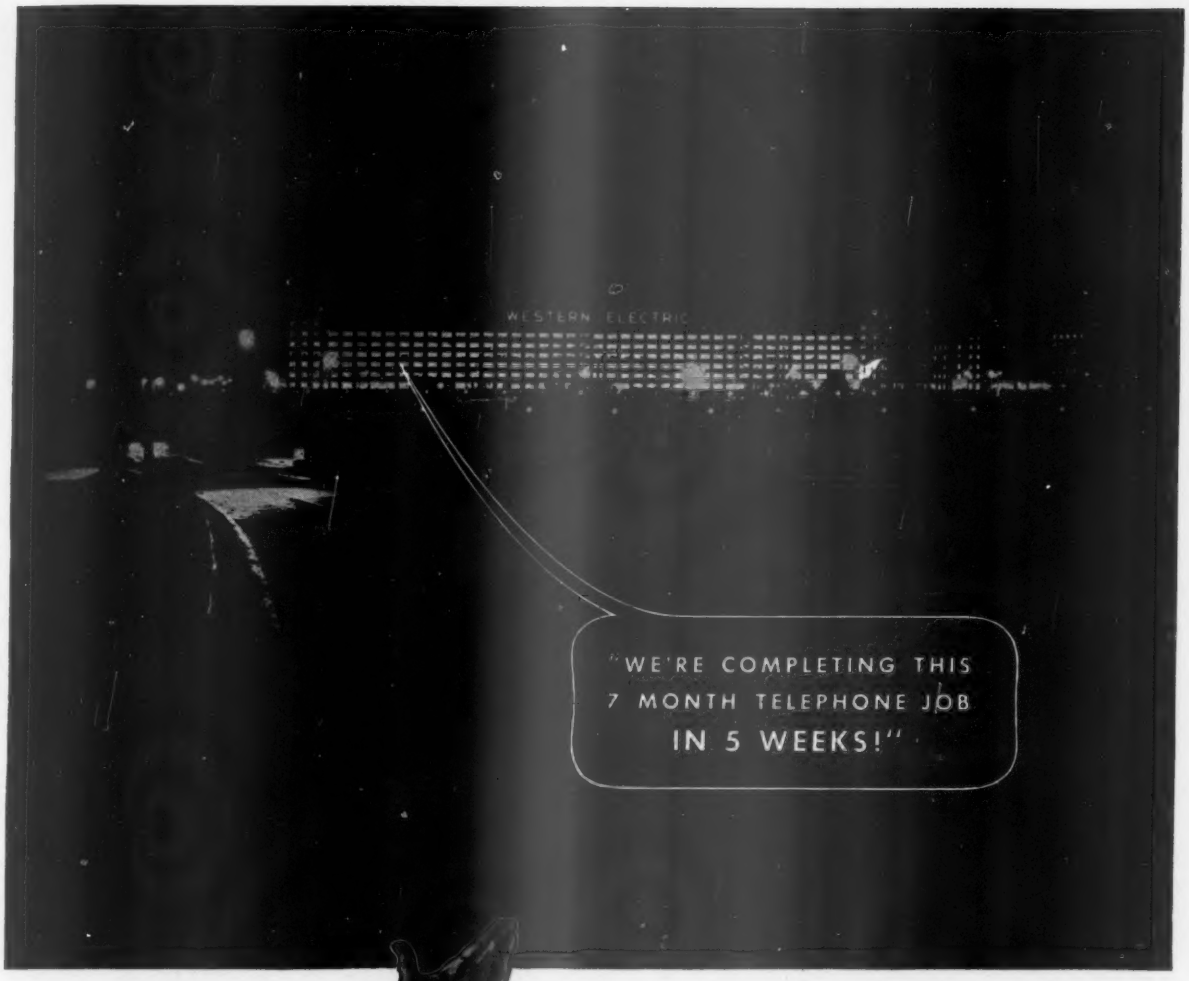

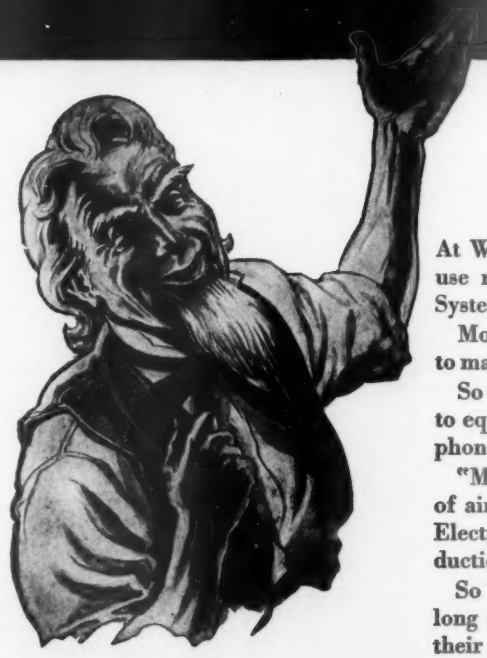

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So in this time of need, as in calmer days, Western Electric's long experience and manufacturing facilities are demonstrating their worth to the nation.

Western Electric ... *is back of your Bell Telephone service*

TOWARD A MILITARY CALCULUS

(*Continued from page 378*)

obsolete as the crossbow of the Ancient Mariner. The special advantage of the tank — indeed, the reason for the invention of it — is its immunity from machine-gun fire. Failure to stop the tank is apparently due to lack of more or bigger tanks and antitank guns, or to faults in antitank guns which are actually on hand, or to faults in handling them.

The 37-millimeter antitank gun is unnecessarily large for use against light and medium (25-ton) tanks but no doubt will be required as larger "land battleships" are built. In order to stop a tank, shells are unnecessary; almost any penetration of its hide is sufficient, for its insides are crammed with vital organs. Shells serve a double duty in that they are also useful against aircraft.

The 105-millimeter howitzer seems greatly superior to the 75-millimeter gun which it was designed to replace. Perhaps for field service any howitzer is better than the corresponding gun, but guns like the split-trail 75, which are adapted to firing against moving targets, are very useful in tank defense. What the layman cannot understand (and he has some professional company) is why fieldpieces are always transported with the muzzles pointed to the rear. In view of the special weakness of field guns during movement, it would be an advantage to have a gun which could come up punching. The ordnance men elsewhere may have their reasons, but in the German caterpillar mount and in the United States medium tank the muzzle of the 75 faces the enemy.

Heavier guns suffer from a slow rate of fire, until we get into the 12-inch class, and apparently are useful for only special purposes. No doubt a complete kit of war tools ought to have a few of them in the bag even if a good workman can get along without them.

The submarine and the fighter airplane are relatively puny weapons. Their records of destruction must be attributed more to their strategic advantages than to their tactical powers. But the bombing airplane is a very powerful piece of ordnance against inadequate defense. Although it ranks far below the battleship and can take virtually no punishment, it is measurably superior in striking power to any ordinary field artillery. Its great weaknesses are its vulnerability and the difficulty of moving forward its bases of operations without violating the neutrality of Norway, Denmark, Holland, Belgium, Luxembourg, and points east.

To compare an entire battleship with a single bombing plane is, of course, unfair, but in Table 2 the basis is laid for comparing the tactical powers of any number of units, as a squadron of airplanes, with any number of other units.

Very little has been said here of armor and the nature of military targets. The effect of armor is to nullify all enemy tactical power of less than a certain ability to penetrate the armor. Roughly, an inch of armor will stop a projectile an inch in diameter; to use machine guns against tanks, or field guns against battleships appears for this reason to be clearly a waste of ammunition. A specific target decreases enemy tactical power in proportion to the target's own (*Concluded on page 382*)

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1936 — *Vitamin B_1 was synthesized in the Merck Research Laboratories.*

1937 — *Vitamin B_1 Hydrochloride Merck (Thiamine Hydrochloride U.S.P.) was made available in commercial quantities.*

1938 — *Nicotinic Acid Merck (U.S.P.) became commercially available.*

1938 — *Riboflavin Merck (Vitamin B_2) was the second pure crystalline vitamin to reach commercial production during the year.*

1938 — *Alpha-Tocopherol (Vitamin E) was identified and synthesized by Merck chemists and their collaborators in other laboratories.*

1939 — *Vitamin B_6 was synthesized in the Merck Research Laboratories.*

1940 — *Vitamin B_6 Hydrochloride Merck became available in commercial quantities.*

1940 — *Alpha-Tocopherol Merck (Vitamin E) was made commercially available.*

1940 — *2-Methyl-Naphthoquinone Merck, a pure chemical having marked Vitamin K activity, became available in commercial quantities.*

1940 — *Pantothenic Acid, the most recently synthesized member of the Vitamin B Complex, was identified and synthesized by Merck chemists and their collaborators.*

1940 — *Calcium Pantothenate Dextrorotatory, the physiologically active form of Pantothenic Acid, was made commercially available by Merck & Co. Inc.*

★ ★ *Greetings* ★ ★

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TOWARD A MILITARY CALCULUS

(*Concluded from page 380*)

smallness, remoteness, and mobility; these hence may be called the target's qualities of indirect protection. The calculations entering into a choice of targets and of the instruments to be used in destroying those targets are matters of strategy rather than tactics. In all ranks of tactical power, strategic considerations are very important and greatly modify the apparent capabilities of weapons. A true index of military strength, combining tactical and strategic powers, is not beyond approximation, but discussion must be reserved for another occasion. For the present it may be said only that the strategic qualities of airplanes are very great in comparison with land arms, but that both classes appear to be in their strategic possibilities inferior to naval weapons.

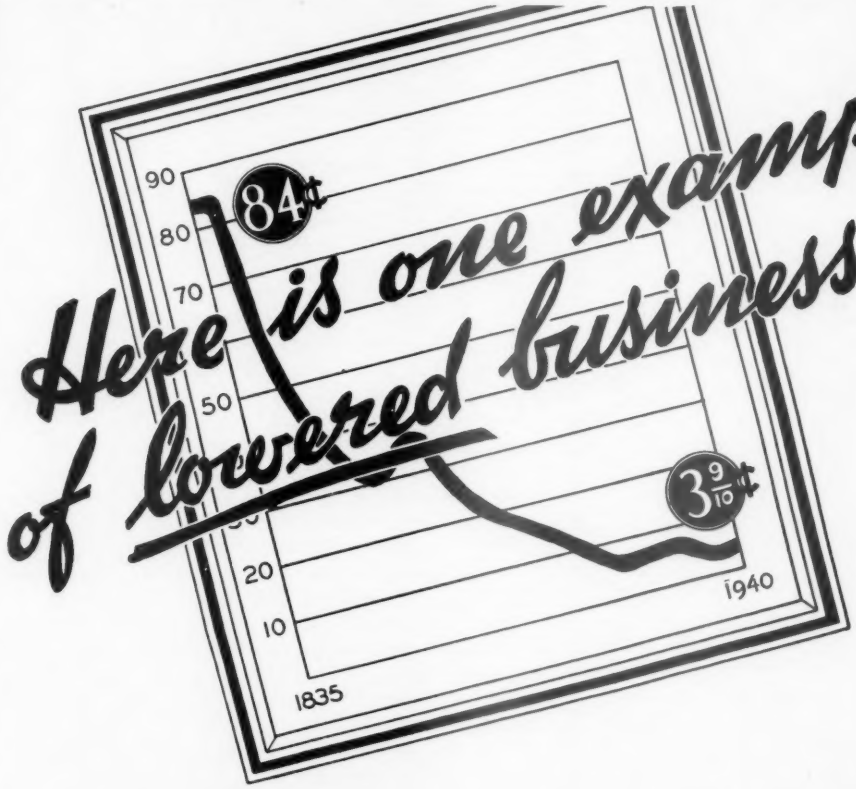
AIDING AGING

(*Continued from page 359*)

(1) *The biology of senescence as a process.* Here our ignorance is profound. Unanswered as yet are such fundamental questions as: Just what happens to a cell with aging? Why does aging occur? What accelerates or retards it? What mechanisms are involved? Why? The elucidation of these basic questions may solve many riddles — among them the riddle of cancer and perhaps that of arteriosclerosis. Scientifically, the cancer problem is but a subdivision of the bigger question of aging.

(2) *The clinical problems of senescence in man.* These questions are clearly divisible into those relating to normal senescence and those relating to abnormality due to disorders associated with advancing years. Normal aging brings many changes, some obvious, others obscure, but all insidious and inevitably progressive. Structural alterations, psychologic changes, and biochemical and physiologic differences arise. "Normal" is not a fixed point but a series of variables which change with age. Chronologic age, as measured in years and months, is not identical with biologic age. Physiologic age varies with each individual. The greater the duration of life, the greater the variation. Furthermore, no individual ages uniformly throughout, for different structures and systems age at different rates at various times in the life span.

The common concept that senescence implies decline alone is distinctly erroneous, for there is considerable compensatory enhancement of certain functional capacities. For example, loss of physical strength and speed of reaction is often counterbalanced by increased skill and judgment. It has been said that the older mind does not learn readily. The popular phrase, "You can't teach an old dog new tricks," has done immeasurable harm, for it has become so fixed in the minds of young and old alike that its validity is assumed. As a result many older people admit defeat before trying and opportunities for adult education are suppressed. Recent and comprehensive studies reveal that once this adult resistance to learning is overcome, the capacity to learn is but very slightly (*Continued on page 384*)



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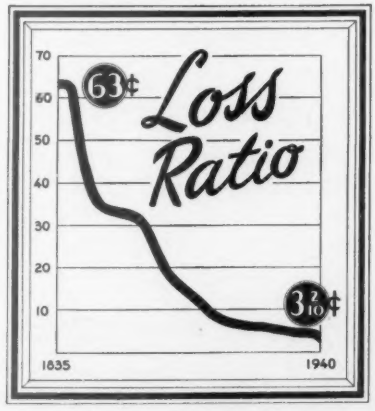

***Note:* "Tech" men predominate in the more important positions of the individual companies that make up the Factory Mutual group and of the jointly operated Inspection Department.**

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AIDING AGING

(*Continued from page 382*)

diminished by aging. There is some slowing of the rate, but there is also an increase in thoroughness. It would be better to reiterate: "It is never too late to learn."

Abnormal senescence hinges on the many disorders whose frequency rises sharply with advancing years. The distinctions between the changes of normal senescence and certain of these so-called degenerative disorders are not sharply defined. To distinguish certain phenomena of disease from those attributable to aging is most difficult. The phenomena of disease are, after all, exaggerations of normal reactions and do not imply new mechanisms. The most significant of these geriatric disorders are cardiovascular-renal disease, arthritis, *diabetes mellitus*, gout, cancer, and certain syndromes of the climacteric. Of all of these the cardiovascular group, including hypertensive arterial disease and arteriosclerosis, is by far the most significant. Arthritis exacts an immense toll of disability, though its mortality is low. A glance at mortality tables reveals that these diseases so frequent in the latter half of life are replacing tuberculosis, accidents, diarrhea, and enteritis as the leading causes of death.

Two characteristics common to all these geriatric disorders are of special concern. First, acute infection plays a negligible role in their etiology. Second, all are chronic and progressive and usually insidious of onset. Often the progression is slow, but it is, nevertheless, inevitably persistent. None are self-limited diseases tending toward spontaneous cure and followed by a protracted period of lowered vulnerability. Rather does the progression of these disorders continuously increase vulnerability to exacerbation and accelerated decline. Cure is largely beyond our present hopes. *Control* and retardation of progression are, however, feasible. The adequately controlled diabetic is vigorous, active, useful, and productive despite the fact that he still remains a diabetic. The earlier in the course of these diseases control measures are instituted, the more effective is the therapy. *More can be accomplished with the aging than for the aged.*

The problems presented to preventive medicine in the later decades of life differ radically from those encountered in younger age groups. The disorders of age are not amenable to mass prevention, as are infectious diseases. They are not contagious. They are progressive. Thus, preventive geriatrics must become individualized, and it must be applied almost continuously.

(3) *Socio-economic problems.* The sociologic problems introduced by increased longevity, greater life expectancy, and the rising median age of the population are immense and extremely complex. Industry is just awakening to the implications of the fact that the average age of employees is increasing at a surprising rate. Problems of placement and retirement, utilization and conservation of the health of older men in positions of great responsibility, the complexities of workmen's compensation laws in relation to occupational exacerbation of pre-existent disease, and many more questions are becoming increasingly (*Continued on page 386*)

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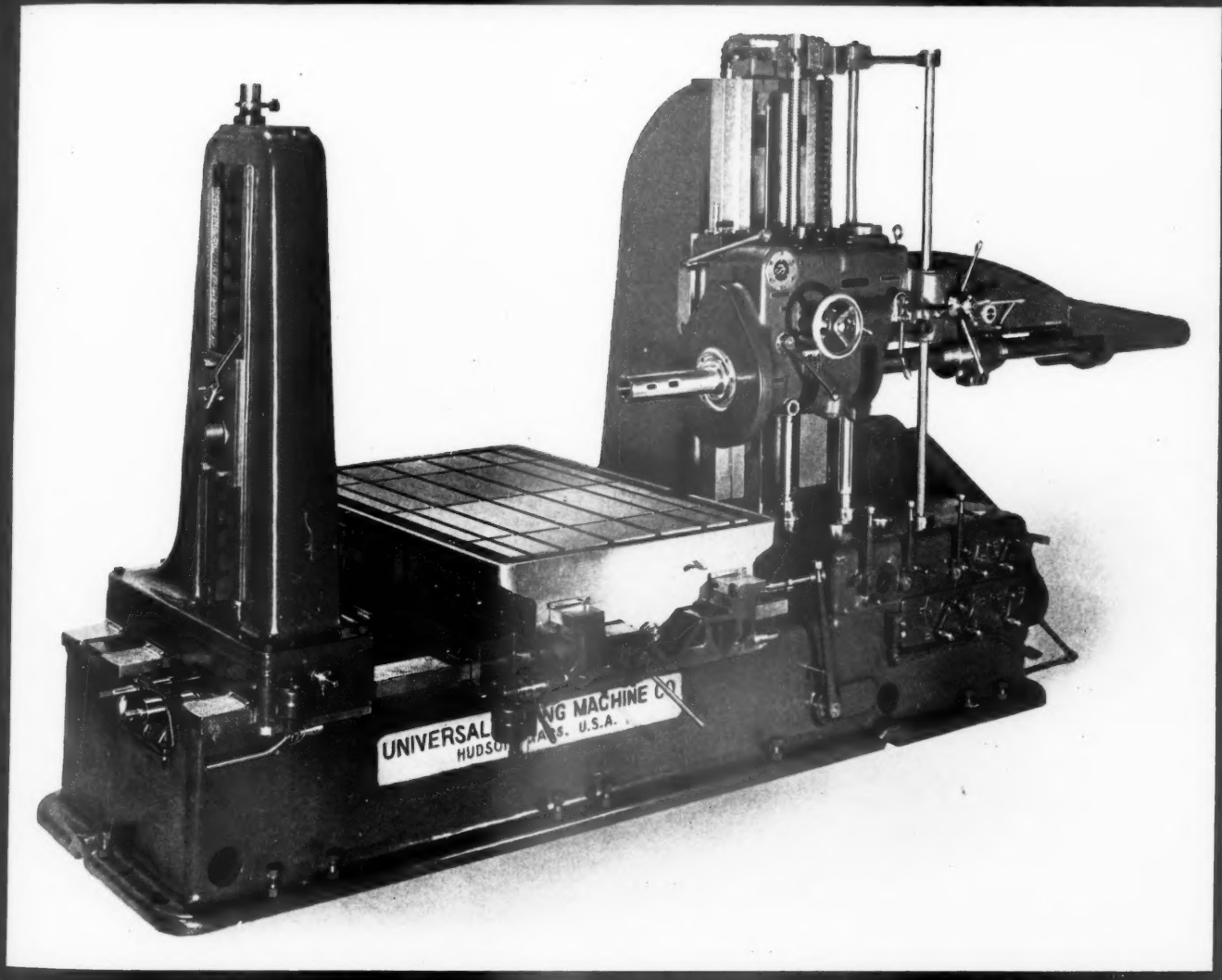

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AIDING AGING

(*Continued from page 384*)

urgent. Certain problems of adult education have already been mentioned. Problems involving social attitudes toward the aged are distinctly pertinent.

Preventive medicine is of two types. These are the impersonal or "wholesale" type and the individual or "retail" form of prophylaxis. Impersonal public health activities have included the institution and control of modern sanitation; the enactment and enforcement of both local and national quarantine regulations; the control of avoidable hazards of atmospheric contamination and of the physical environment in industrial plants, schools, public buildings, and homes; the directing of educational activities in schools and elsewhere toward the control of communicable diseases; and the encouragement and application of mass immunization against certain infective diseases. These methods resulted in magnificent improvements in the health of our youth. Notable, however, is the fact that though life expectancy at birth increased nearly fourteen years in the quarter century from 1910 to 1935 (from 46.3 to 60.2), life expectancy at fifty years increased but 2.8 years (from 18.3 to 21.1). There is reason to pause and consider why the gains have been so asymmetric.

Both these approaches toward health maintenance have their limitations. Impersonal preventive medicine, which has been the mainstay of public health work in the past, is limited in its effectiveness almost solely to infective and communicable diseases. It is feasible only with relatively homogeneous groups, which require a minimum of individualization, for mass production is effective only as long as the units dealt with are identical or nearly so.

Personal preventive medicine, on the other hand, requires individualized handling of health problems. Such health maintenance activities are illustrated by the better student-health services, by periodic examinations in industry, and to a more limited degree by practitioners of medicine. Included in programs of individual health maintenance must be provision for therapy to control in their incipiency the progressive disorders of later life.

With increasing age, individual variability increases. The limitations of personal preventive medicine as applied to older individuals are hence quite different. In the first place a great deal of time is required for proper individualization. To detect chronic and progressive disorders early is more difficult and time consuming than to diagnose frank disease. Furthermore, in order to prevent, control, or retard these disorders, frequent consultations for observation and guidance are necessary. Such work cannot be hurried, and requires the highest type of diagnostic acumen.

Another and severe limitation to the effectiveness of individual preventive medicine lies in mankind's curious perversity in declining to make prophylactic efforts on his own behalf. The best advice is relatively useless if not followed. Impersonal preventive medicine deals largely with matters which require little or no effort on the part of the recipient of the

(*Continued on page 388*)

A STATEMENT IN UNIQUE FORM

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Boston Insurance Company
INCORPORATED 1873

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Losses in Process of Adjustment	$ 868,661	Cash	$ 868,661
Reserve for Losses Unreported	226,500	Cash	226,500
Reserve for Federal Taxes	38,000	Cash	38,000
Reserve for Dividends	270,000	Cash	270,000
		Cash	427,128
Unearned Premium Reserve	4,829,763	U. S. Government Bonds	4,178,625
		State, County and Municipal Bonds	224,010
		State, County and Municipal Bonds, Railroad Bonds, Public Utility Bonds and Corporation Bonds	1,698,621
All Other Reserves and Liabilities	1,777,259	Canadian Government, Provincial and Municipal Bonds	78,638
		Canadian Government, Provincial and Municipal Bonds	63,047
Capital $3,000,000		Stocks	7,083,204
Surplus 14,416,409		Old Colony Insurance Company	8,122,359
Policyholders' Surplus	17,416,409	Real Estate (Home Office Building)	975,000
		Premiums in Course of Collection and other Admitted Assets	1,172,799
	$25,426,592		$25,426,592

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AIDING AGING

(*Continued from page 386*)

benefits. Personal efforts, often of considerable degree and sometimes involving irksome restrictions, are absolutely essential in the management of early degenerative disorders to retard their progression.

A further difficulty arises from the fact that though new curative methods of treatment are immediately taken up by both physicians and the lay public, prevention of diseases is not regarded as a matter of urgency, and adoption is therefore slow. Those diseases which hurt early, receive prompt attention. Geriatric disorders, being insidious and painless in their beginning, are usually neglected.

The greatest obstacle to effective preventive geriatrics is this inertia. It is not an insurmountable obstruction. Vaccination was introduced against violent agitation. Even today there is much passive resistance to many procedures of preventive medicine. Education is gradually diminishing this resistance, but education is not accomplished overnight. The course in education to overcome the general inertia of adults toward personal preventive medicine will be a long and arduous program.

Public health services can do much to forward preventive geriatrics. Education of the adult population in the importance of prevention, control, and retardation of the chronic and progressively disabling diseases of later life will encourage the seeking of thorough periodic health inventories. If people request these and are aware of the necessity for comprehensive thoroughness, the services will become available. Today it is often extremely difficult, even in the larger cities, to find physicians whose primary interest is to maintain health rather than treat disease. The pediatricians are the exception.

Yet it is entirely clear that such personal preventive medicine is necessary if we hope to check the ever increasing numbers of middle-aged and elderly people partially or totally disabled by chronic illness. The economic burden of chronic illness is already a staggering fraction of the total losses due to ill-health. Mental disability requiring institutional care must be included in these considerations. It is noteworthy that within the last twenty-five years admissions to state hospitals for mental diseases due to cerebral arteriosclerosis increased from 7.7 to 49 per 100,000 population over forty years of age; this is an increase of over 500 per cent.

Industry is much concerned with these questions, and industrial medicine is in a particularly advantageous position to advance preventive geriatrics. To emphasize the importance of adult preventive medicine we need only note that sickness absenteeism of nonindustrial origin is responsible for about *twenty times* as much lost time as are industrial injuries of all sorts. Not only do industrial physicians have the opportunity to examine hundreds of thousands of new employees each year but they have the invaluable privilege of re-examining these same men and women at periodic intervals for many years. The factory stands in much the same relation to many adults as the school stands to children. The role of school physician and (*Concluded on page 390*)

IT CAN HAPPEN AT ANY BREAKFAST TABLE!...
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AIDING AGING

(*Concluded from page 388*)

school nurse in developing prophylactic pediatrics was and is most significant. A similar opportunity to develop and apply prophylactic geriatrics awaits industrial physicians and nurses.

The greatest and most important service which public health can offer the older fraction of our population is research into the problems of aging. Here the field is so wide, so untrammeled, and so unexplored that the potentialities are truly without end. I have deplored our ignorance of the fundamental biologic process of senescence. Badly needed are accurate and controlled studies to reveal what actually happens with aging.

Clinical researches are needed just as urgently. We mention but two of the problems clamoring for solution: how to evaluate physiologic age in man, and how to define curves of "normal" in relation to age. Solution of these problems is prerequisite to studies into most geriatric diseases. Present clinical methods of functional mensuration need critical appraisal, and new, more precisely controlled stress-test procedures are wanted. Any advance in knowledge concerning the so-called degenerative diseases advances geriatrics; but we must not forget the lesson learned from pediatrics: that the greatest advances were made when the peculiar structural, biochemical, and physiologic characteristics of the infant and child became more clearly defined.

Prophylactic geriatrics does not take as its primary objective the prolongation of life. In the words of George Morris Piersol and Edward L. Bortz, "It is for science not only to add years to life, but more important, to add life to the years." Older individuals can be permitted to remain useful much longer if they understand and develop their capacities. No greater tragedy for the aged exists than the sense of uselessness which society today prematurely imposes upon them.

We must not forget that the posts of greatest responsibility — requiring the highest judgment, technical training, and wisdom — are held by older men. And with good reason. The accumulated judgment and wisdom of these older minds represent one of the most valuable and potent resources of the nation. The conservation of the health and vigor of these almost irreplaceable older men is a major potentiality of preventive geriatrics.

RIDING FENCE

(*Continued from page 361*)

At one time the large rigid airship of the Zeppelin type was believed to be the ideal craft for long-range scouting and patrol. Ten years' experience with big rigids (terminating with the loss of the *Macon* in 1935) proved disappointing, and at the moment the Navy has put on the shelf most of its plans for very large airships. A new program is in progress, however, for lighter-than-air craft, for smaller airships of the nonrigid type. They are to be spotted at strategic points around the rim from Newfoundland to Alaska, where they will be used principally for antisubmarine patrol and scouting duties. But "riding fence" around the (*Continued on page 392*)

A QUARTER-INCH TO COMFORT *with* TAYLASTIX *stretchable* LACES

These photographs illustrate how Taylastix stretchable laces adjust themselves, so that they always fit snugly and comfortably whether the foot is at rest as above, or flexed in walking as below.

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RIDING FENCE

(*Continued from page 390*)

areas vital to United States interests is only one of the jobs for the fleets that fly. It is only one of the elements of naval aviation's major mission — to increase the effective striking power of our fleets.

To help the battle fleets most effectively, naval planes and pilots must be able to go to sea with them. Planes must operate whenever and wherever battleships operate, under all sorts of conditions from the tropics to the poles. No small assignment, this! Only thirty years ago pilots stayed on the ground if more than a breath of air was stirring. They seldom dared go out of sight of land or fly where they could not see the ground. Today it is routine to launch fighters and scouts in anything but a full gale at sea. Pilots fly blind for hours in fog and rain and ice, searching out objectives hundreds of miles under horizons, and then return to their home ships without difficulty.

To protect surface vessels against attack by enemy bombers, fast heavily armed fighters must be available. These agile aerial destroyers can fly rings around most bombers. Their concentrated fire power from quick-firing cannon and machine guns makes them the equal of any adversary. They are limited in their field of action, however, because they are small and packed with power. Such aircraft would be of little use if restricted to operation from fixed bases. They must be able to go to sea with the fleets, if they are to be of maximum value. The aircraft carrier provides the solution. These seagoing airports can keep up with the surface fleets. Their swift fighters can be sent up in swarms to beat off any attack against the battleships and cruisers of the fleet. Their dive bombers and torpedo planes can effectively attack enemy battleships far out at sea.

Until the seagoing airplane came along, a sailor's horizon was limited to what he could see from the topmast of his tallest ship. Fifteen or twenty miles were the best he could hope to survey even under the most favorable circumstances. Enemy fleets forty or fifty miles away were out of sight as well as out of range. Today, however, horizons at sea have been tremendously extended. Scouting airplanes cruise for hundreds of miles around battle fleets, reporting their findings by radio to commanding officers. Once surface fleets are in contact, high-flying observation planes report hits and misses to gunners who are firing at targets far beyond their range of actual vision.

Every United States cruiser and battleship carries two to four airplanes for scouting, range finding, and general observation. These are usually two-place seaplanes launched from catapults carried on board. Returning to their ships, they land in the water alongside and are taken back aboard by cranes. They are generally armed for defense only, and are fitted with elaborate equipment for photography and communication.

Besides its patrol bombers, fighters, torpedo carriers, and scouts, the Navy also carries on its rosters many utility types — cargo carriers to transport needed parts and equipment between shore bases, amphibians to shuttle matériel and personnel from ship to shore or shore to ship.

Such an array of tactical and transport aircraft cannot be handled by amateurs. Each pilot of our flying fleets must be an expert flyer and a specialist in his particular branch. Hundreds of training airplanes are being provided at naval training stations to turn out pilots for the fleet. Trainers range from relatively simple low-powered planes, good for elimination training only, up through fully armed tactical machines in all categories, for advanced work.

Most of the airplanes used for elimination training and primary flight work at the flying school at Pensacola are made in the Navy's own aircraft factory at Philadelphia. But the Navy can build only a fractional part of its aircraft requirements. For efficient aircraft of all types for its flying fleets the Navy must depend primarily on the private manufacturers of planes, engines, and accessories. For years the manufacturing people have accepted specifications for naval airplanes that were always a little better than they thought they knew how to make. The present high standards of performance and reliability now accepted as commonplace would have been wholly impossible without the complete cooperation of the contractors. Through all the lean and uncertain years of development and depression, these contractors have never let the Navy down.

When the Navy began to take an interest in the airplane, to fly anywhere was newsworthy. The Ely and Curtiss flights of 1910 and 1911 to and from battleships made headlines all over the world. Now, scouts and fighters are catapulted from cruisers and take-off carrier decks hundreds of times a day in all kinds of weather, and nobody bats an eye. Whole squadrons fly nonstop in formation for thousands of miles and receive but scant mention in the public prints. Aviation has become an indispensable and accepted part of our Navy.

From *Old Ironsides* down to the latest high-speed turbo-electric cruiser, the history of our surface Navy covers some hundred and forty-four years. Only thirty years have gone by, however, since Curtiss flew his crude "hydro" from North Island to pay a duty call on the skipper of the *Pennsylvania*. In those three decades the men of our flying fleets have developed a tradition that matches that of their seagoing comrades. In those thirty years is a story of which all Americans may well be proud.

INDUSTRIAL MATHEMATICS

(*Continued from page 363*)

of the right type have been forced to come here, and a few others have been developed within our borders. No university has yet brought the group together permanently to establish a center of training in industrial mathematics. It would be reasonable to estimate an industrial demand for about ten *exceptional* graduates a year from such a source. Industry today has about 150 qualified mathematicians.

Industrial mathematicians differ from their engineering and scientific colleagues, from whose number they have been derived, in the character of their thinking rather than in the use to which it is put. In the first place, the typical "mathematician" feels great confidence in a conclusion reached (*Concluded on page 394*)

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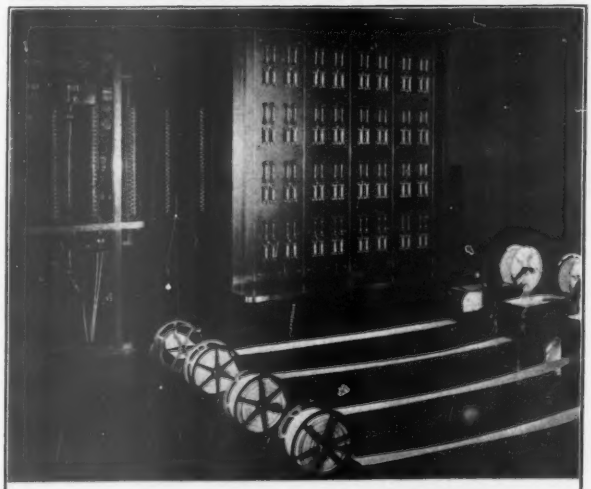

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INDUSTRIAL MATHEMATICS

(*Concluded from page 393*)

by careful reasoning and is not convinced to the same degree by experimental evidence. He turns naturally, therefore, to pencil and paper in many situations where engineers or physicists would resort to the laboratory.

His second typical characteristic is his highly critical attitude toward the details of a demonstration. With almost any other class of men, an argument may be good enough, even though some minor question remains open. For the mathematician an argument is either perfect in every detail, in form as well as in substance, or else it is wrong. There are no intermediate classes. He calls this "rigorous thinking."

In the third place he tends to idealize, as he calls it, any situation with which he is confronted. For example, when consulted about a heavy pipe fitting, the thickness of whose casting had at different points been varied according to experimental data in order to strengthen it where strength was supposed to be most needed, he suggested a theoretical basis for redesign which reduced the weight to half while doubling the bursting strength. His method involved idealization, for he considered the casting as an elliptical cylinder under hydrostatic pressure. The stresses for that idealized structure were already known. The design was then accomplished by making the thickness at each point sufficient to withstand these stresses.

A fourth and closely related characteristic of the mathematician is his desire for generality. He likes to write the general equation and to solve it, thus obtaining all the solutions, including the particular case about which he was consulted. If asked to study the torsional vibration of a fiber loaded at one point, he would be most likely to work out the relationships for a fiber with any desired number of loads at arbitrary points along it.

Because of these habits of thinking, the successful industrial mathematician is essentially a consultant. Hence he not only must be competent as a mathematician but also must possess the special qualities which a consultant must have. Although his major interests will necessarily be abstract, he must have sufficient interest in practical matters to furnish stimuli to himself for useful work and to reconcile him to the compromises and approximations which are necessary even in the theoretical treatment of practical problems. He must be gregarious and sympathetic, keep in touch with his colleagues, and translate his thoughts into their language.

He must be co-operative and versatile, and of outstanding ability in his line. His success must be judged by what the engineers who consult him think of his ability and not by the dollar value of the jobs in which he assists. His salary, in other words, should be based upon the size, character, and satisfaction of his clientele in his company and not upon the commercial importance of the questions they see fit to bring him. The money value of various bits of theoretical work has almost no correlation with the scientific acumen which they require.

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M.I.T., CAMBRIDGE, MASS.

THE TREND OF AFFAIRS

(*Concluded from page 346*)

for a heavier coat of wool, for example, breeders have added so much skin and hair to the animal that the lamb sometimes has difficulty in locating the ewe's udder, and fundamental body functions are frequently interfered with.

The intensification of one characteristic until it begins to affect an animal's vitality appears to be evident in heavily producing cows. A good milk producer — good from the dairyman's point of view — produces in the course of a year six to ten times as much milk as does a wild cow, obviously an amount grossly in excess of what is needed for the support of a calf. It is estimated that at full lactation the heart of a heavy producer must deliver one-quarter of its output to the udder. Some breeders believe that such animals are suffering increasingly from reproductive difficulties and diseases, particularly udder infections. Substantially the same situation has been encountered with poultry which has been bred to attainment of the utmost results in egg production.

THE INSTITUTE GAZETTE

(*Continued from page 368*)

elected to the National Nominating Committee for District 8; Winter Dean, '21, for District 9; and Edward E. Scofield, '19, for District 10. In Districts 9 and 10 the elections were closely contested. C. Frank Allen, '72, Belvin T. Williston, '77, Giles Taintor, '87, Charles F. Park, '92, Charles B. Breed, '97, Frederick H. Hunter, '02, Octavus L. Peabody, '07, Carl W. Somers, '12, H. E. Lobdell, '17, C. Yardley Chittick, '22, Dwight C. Arnold, '27, Thomas E. Sears, Jr., '32, and Philip H. Peters, '37, were elected council representatives for their respective classes.

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Elections by the Council included those of Elbert G. Allen, '00, to the Committee on Audit and Budget; Arthur L. Townsend, '13, to the Committee on Historical Collections; Frederic H. Keyes, '93, and Burton G. Philbrick, '02, to the Nominating Committee for Departmental Visiting Committees; and Alfred T. Glassett, '20, to the Alumni Fund Board. The Council by special vote expressed hearty thanks to Donald G. Robbins, '07, for his long and faithful service as chairman of the Advisory Council on Musical Clubs, which post Mr. Robbins has had to relinquish, though he has consented to remain for another year as a member of the committee.

The speaker of the evening was Sverre Petterssen, Head of the newly formed Department of Meteorology, who gave a very interesting illustrated talk on the development of modern theories of weather.

Visiting Committee Reports

REPORTS of Departmental Visiting Committees, surveying Institute education, appear periodically in The Review as authentic information for Alumni interested in scholastic developments. Those for the Department of Geology and the Medical Department follow:

DEPARTMENT OF GEOLOGY *

AT a meeting with Warren J. Mead, Professor of Geology, and members of his Department, the Committee were impressed with the general program of teaching and the methods which have been used to stimulate the thinking of the student. We were particularly interested in the research work carried on under the direction of Professor Mead and the several staff members. The Committee are of the opinion that the study done in mining methods, valuation, costs, mineral economics, and so on might well be expanded, as that work is of extreme importance.

The Committee made a thorough inspection of facilities and space allotted for carrying on the work of the Department. The principal need seems to be better quarters for undergraduate teaching, particularly in general geology and engineering geology. This need could be remedied through a rather thorough revision of space utilization, but expansion of the space to the extent of finding quarters for the mechanician's shop is also necessary. Space should be provided for the facilities of geophysics, which are now housed in a very inadequate dark room behind the elevator shaft — a room suitable only for storage purposes. Plans for the rearrangement, including the provision and better distribution of the cases containing samples and so on, have been made, as have studies of detail costs and prices of the rearrangement itself. The Committee are convinced that these changes would result in a more effective carrying on of the work.

The Committee are much pleased with the spirit and industry of the Department, and we are sure that the staff will do a good job even (*Concluded on page 398*)

* Members of this Committee for 1940–1941 are Francis J. Chesterman, '05, Chairman, George E. Whitwell, '14, Hugh E. McKinstry, '21, Jesse L. Maury, '25, William O. Hotchkiss, Gordon S. Rentschler, and Neil Rice.

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THE INSTITUTE GAZETTE

(*Concluded from page 397*)

though the facilities are not adequate to enable them to work most efficiently. The Committee desire to express their appreciation of the co-operation of Professor Mead and his associates in enabling us to review effectively the activities of the Department.

MEDICAL DEPARTMENT *

THE Committee desired to express their thanks to the Charles Hayden Foundation and to J. Willard Hayden for the provision of funds for the dental clinic. The equipment for this clinic has been ordered and, it is expected, will be installed and available for use at the start of the coming Institute year. Because of governmental priorities, however, there may be some delay in the procurement of material.

The x-ray equipment previously provided by Mr. Hayden is found to be working satisfactorily and has increased the Department's effectiveness. This equipment will be available for use in the dental clinic.

Dr. George W. Morse, medical director, submitted to the Committee a report (which was approved) on the Department's operations. The report indicated the continued successful operation of the Department and the important part it plays in maintaining the increasingly high standard of health at the Institute. Dr. Morse reported that the paper work in the Department is on the increase because of additional army and navy examinations.

The Committee pointed out that at some future time the Department will need more space, and placed on record the fact that the Department desires to have eventually all the space for which Building 11 was originally designed. The Committee were in agreement with Dr. Morse's feeling that there is need for a psychiatric service.

The Committee expressed their appreciation of the earnest endeavor and good work of Dr. Morse and his associates during the year.

* Members of this Committee for 1940–1941 are Page Golsan, '12, Chairman, William R. Kales, '92, Dr. John A. Rockwell, '96, Dr. James H. Means, '06, Dr. Reginald H. Smithwick, '21, J. Willard Hayden, and Horace Morison.

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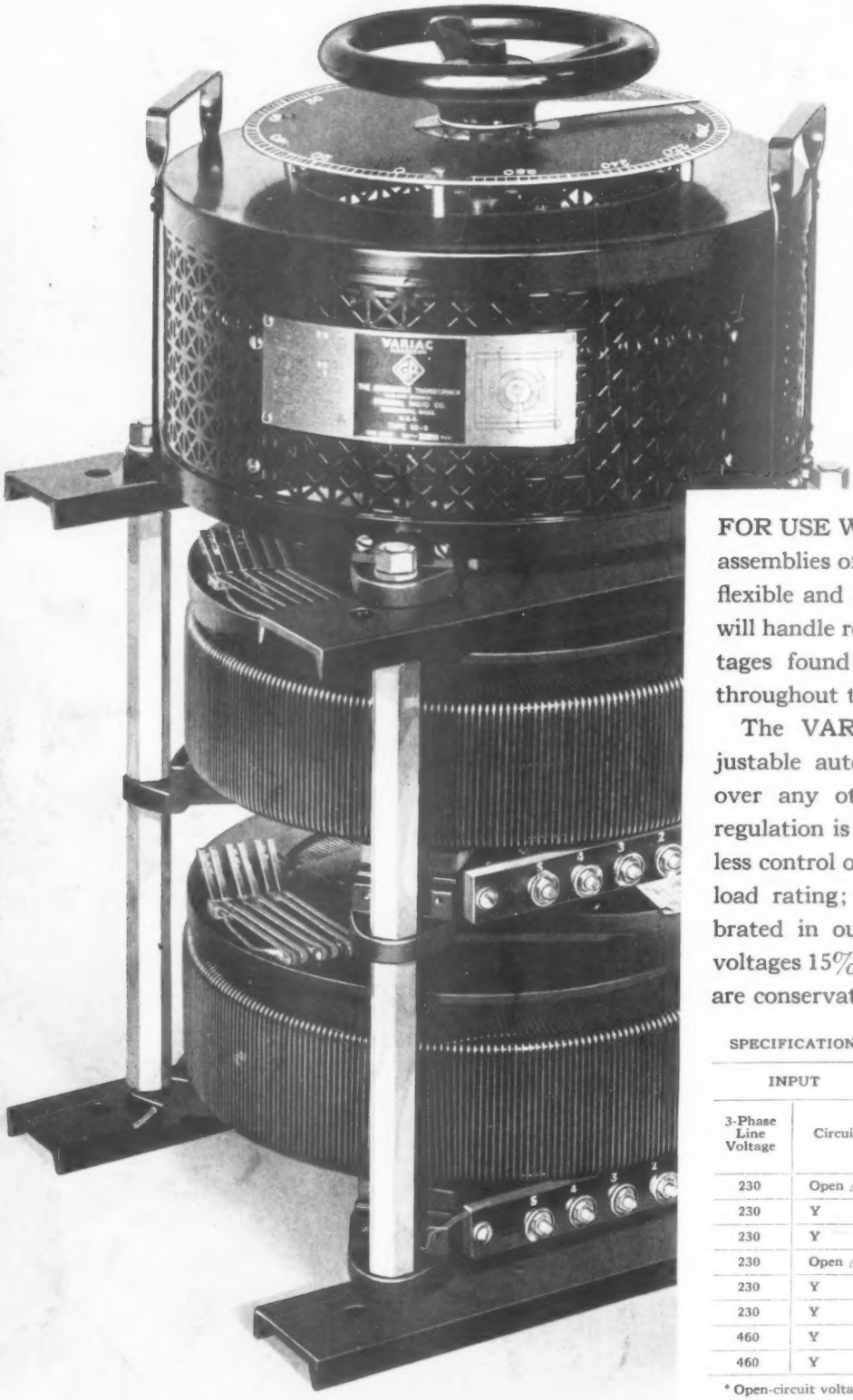

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* Open-circuit voltage — regulation is poor for this connection

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